POWER PLANT ENGINEERING

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Plant of The James Leffel & Co.

PLANT DEVOTED TO THE MANUFACTURE OF WATER TURBINES GENERATES STEAM FOR POWER, LIGHT AND HEAT

WHEN THE ENGINEERS of The James Leffel & Co. at Springfield, Ohio, manufacturers of water turbines, boilers and engines, decided to erect an entirely new factory about two years ago, they resolved to incorporate in its construction all the features known to modern engineering which would make the plant one of the most up-to-date of its kind. Unfailing service and efficiency were the keynotes to which all specifications for the new factory were tuned, and the result seems to have justified and rewarded their efforts.

Although at the time of writing, the finishing touches have not been fully applied, this factory was put in operation about three months ago, and comprises nine buildings located as shown in Fig. 2 and enumerated as follows: No. 1, water wheel building; No. 2, boiler shop; No. 3, power plant; No. 4, sand house; No. 5, core room and coke bins; No. 6, foundry; No. 7, pattern shop; No. 8, carpenter and pattern shop; No. 9, office building.

These buildings with the exception of the office building are all of one story construction, thereby insuring an abundance of natural illumination for all manufacturing purposes. All buildings are of brick, steel, and glass construction and with the exception of the floors which are of impregnated wood block, nothing combustible is used in their construction. The necessity of providing elaborate fire protecting equipment is therefore

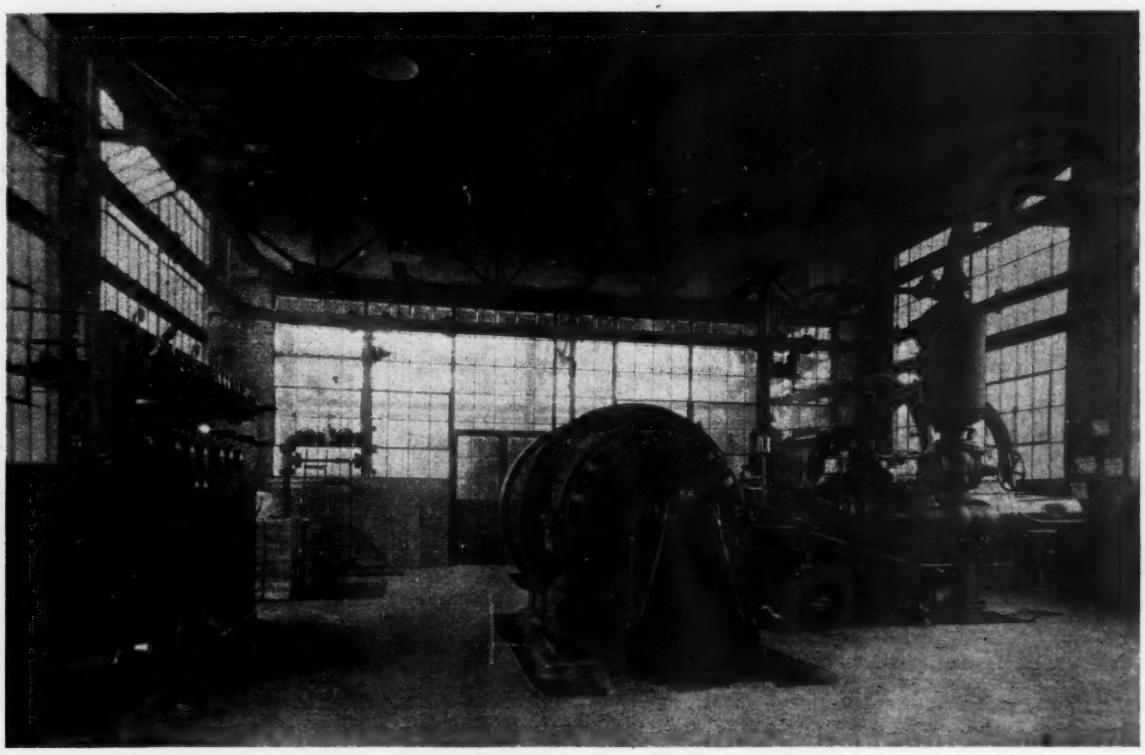


FIG. 1. GENERAL VIEW OF ENGINE ROOM

eliminated in all the buildings except in the pattern and carpenter shops and in the office building which are fitted with modern dry sprinkling systems.

The purpose followed in the design of the buildings was to spread them over a large area rather than to construct higher ones with more floors, in order to facilitate movement of products through the factory and to insure adequate natural illumination. The combined length of the water wheel and boiler shop building alone is over 1000 ft. All buildings are heated by steam from the power plant with the exception of the office building which has a separate heating plant of its own. Thus in times of shut-down of the factory and power due to unforeseen conditions, the office building may be heated by its own plant. The factory heating system is of special interest and will be described in detail in the latter part of the article.

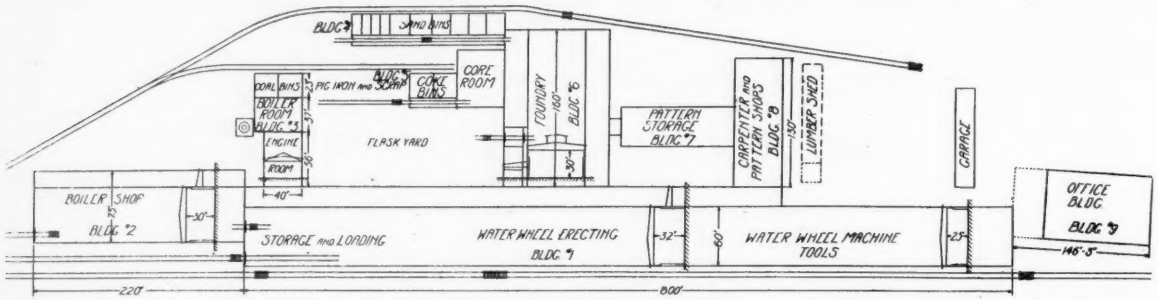


FIG. 2. PLAN OF NEW FACTORY

At night, illumination in the shop is effected by the use of mercury vapor lamps supported from the roof trusses by steel fixtures. All machinery throughout is driven by individual electric motors, and all air devices are served by an extensive compressed air piping system. Hot and cold water for washing purposes is supplied to all parts of the factory and an excellent system for continually circulating hot water through the system enables hot water to be drawn from any faucet instantly at all times.

The Power Plant

The power plant was built in accordance with the same up-to-date features which characterize the construction of the shops. It was built with the express idea of rendering uninterrupted service with a maximum of efficiency under all conditions. Provision is made, however, in case of accident to the generating equipment or from other causes, to supply the factory with central station power, a motor generator being installed for this emergency. This can also be used to help out in case of excessive load requirements. Under all normal full load conditions, however, the capacity of the factory power plant is entirely adequate to carry the load.

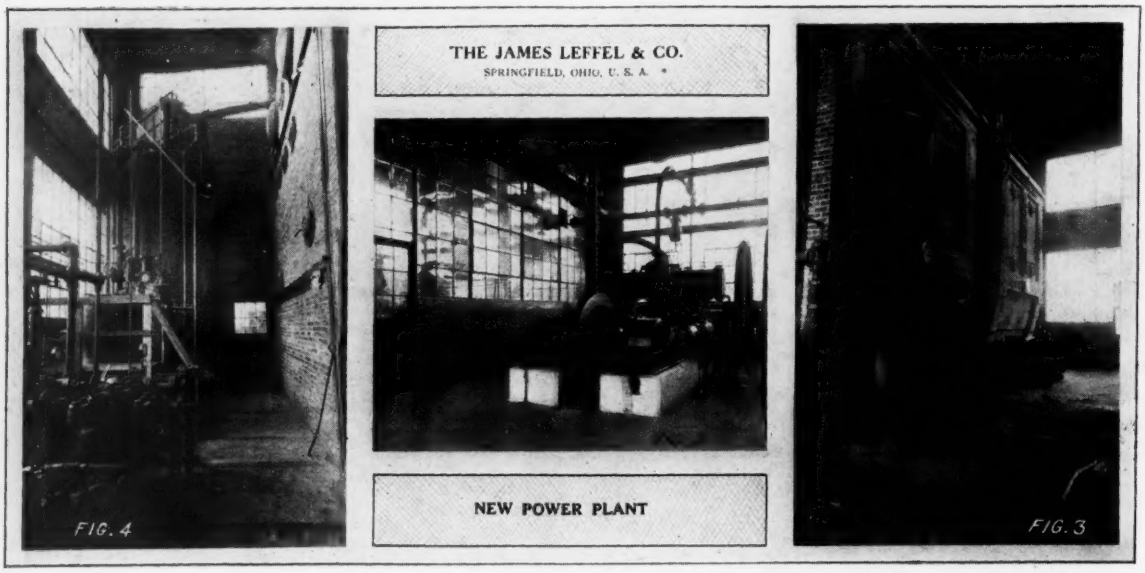


FIG. 4. WATER SOFTENING APPARATUS FIG. 5. CROSS-COMPOUND AIR COMPRESSOR FIG. 3. VIEW IN BOILER ROOM

Steam Generating Equipment

The boiler house is of brick and steel construction amply lighted by large windows on two sides and skylight windows on three sides.

Steam is generated at normal pressure of 140 lb. by two 308-hp. water-tube boilers, equipped with underfeed

stokers. There are two retorts to each stoker, the operation of which is automatically controlled by a regulator which operates the retorts successively. This retort regulator is driven by a 7 by 10-in. reciprocating engine which also drives the forced draft blowers. This blower engine is in turn automatically controlled by the steam pressure through a diaphragm. Dampers are operated by hand, no regulator being employed.

The stoker hoppers are filled by hand. This feature at first may not appear in accordance with the design of the plant as a whole, but when it is considered that one man can easily keep the stoker hoppers filled at all times, the reason for the absence of mechanical coal handling equipment may be appreciated. The size of this plant is relatively small, and this method of filling the hoppers was decided upon as being the most economical solution to the coal handling problem. Coal is delivered to bunkers located directly in front of the boilers and by opening slides, the coal discharges on the boiler room floor and is shoveled into the stoker hoppers with a minimum expenditure of labor. The arrangement is shown clearly in the photograph, Fig. 3.

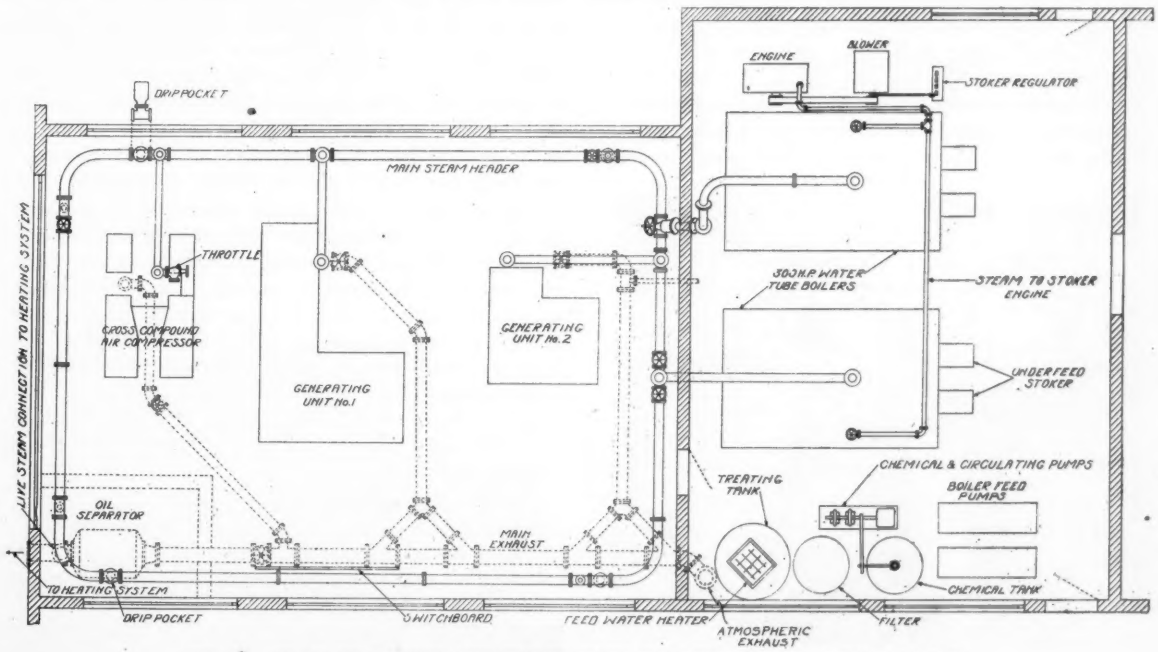


FIG. 6. PLAN OF ENGINE AND BOILER ROOM SHOWING PIPING ARRANGEMENT

All boiler feed water is well water and is treated by the hot process softening apparatus shown in the photograph, Fig. 4. This apparatus is entirely automatic, and is fitted with a differential pressure-operated, chemical proportioner which feeds the chemicals to the water in strict ratio to the amount of feed water used. The boiler feed water heater is located on top of the treating tank as shown in the photograph. This feed heater not only heats feed water to the boilers, but also heats all water used for washing purposes in the factory. The

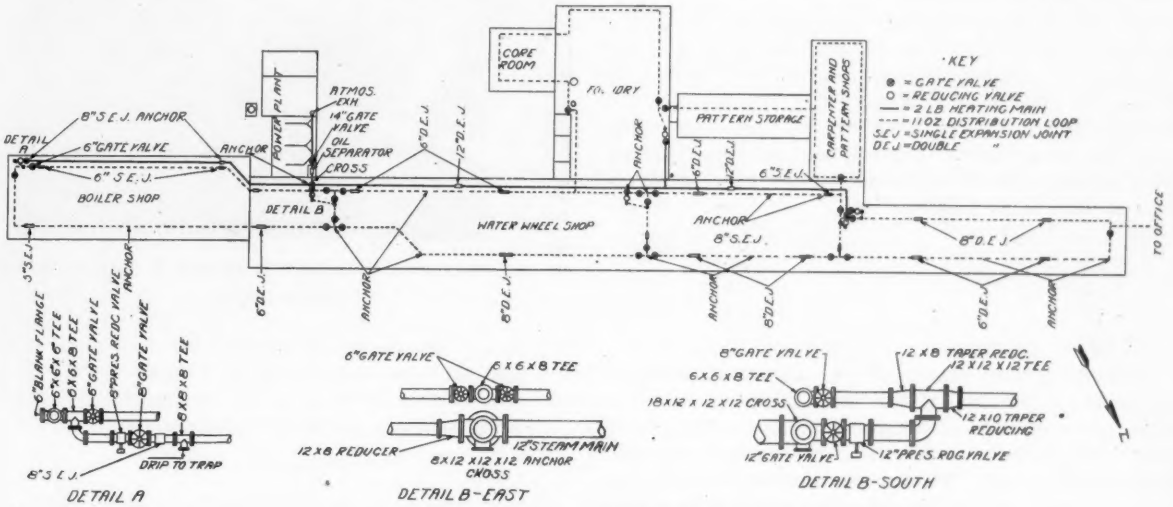


FIG. 7. PLAN OF HEATING SYSTEM

normal temperature of the feed water rarely falls below 220 deg. F. To insure clean boilers and to check the efficiency of the treating apparatus, a daily analysis of the water is made.

Two 7½ by 4½ by 10-in. duplex, outside packed, plunger pumps are employed for boiler feed purposes. These pumps are fitted with automatic regulating and bypass valves and can be seen in Fig. 4.

The Engine Room

The construction of the engine room is similar to that of the boiler room and the equipment is arranged as shown in Fig. 6. The engine room floor is on a level

FIG. 8. PHOTOGRAPH OF HEATING MAINS EMERGING FROM UNDER BOILER ROOM FLOOR

with that of the boiler room and the factory, hence all piping is as short and direct as possible. As may be seen in the photograph, Fig. 1, the engine room opens directly into the factory.

Generating equipment consists of two direct-current generators and engines. At the time the accompanying photograph was taken, however, only one of these generating units had been installed. This one, shown on the photograph, is a 200-kw., 250-v., 800-amp. machine direct connected to a 500-hp. Uniflow engine. The average steam consumption of this engine under varying conditions of load is as follows:

Percentage of load	Steam, lb. per hp. per hr.
25	19.58
50	19.28
75	19.46
100	19.9

The switchboard consists of six, two-section panels of 2-in. black oil-finished slate, 90 in. high, mounted on angle iron supports and comprises two generator panels, one rotary converter panel, two feeder panels and one future feeder panel. The rotary converter is located in a separate compartment in the water wheel factory and, as stated before, is only provided for use in case of emergency.

A 14—22 and 20—12 by 14 cross-compound, two-stage air compressor furnishes air under a pressure of 100 lb. per sq. in. to the factory. This machine is equipped with after cooler and intercooler and has a capacity of 1500 cu. ft. of air per min. It is entirely automatic in operation, being controlled by the air pressure in the system.

In addition to the equipment described the engine room contains the two water service pumps; one a 6 by 10 by 7 by 12-in. tandem, compound, duplex, direct-acting pump for general cold water service; and the other, a 6 by 4 by 6-in. duplex, direct-acting hot water circulating pump. The latter is used to circulate hot water through the factory and is automatically controlled by the water pressure which is kept constant at about 50 lb. per sq. in. The arrangement makes it possible to draw water at a temperature of from 180 to 200 deg. from any faucet in the factory at all times.

Piping arrangements in the engine and boiler room are of exceptional excellence. As shown in Fig. 6, the main steam header in the engine room is constructed in the form of a rectangle, extending completely around the room. Steam is fed into this system directly from the boiler headers as shown. Eight-inch cast steel drip pockets at each corner of the rectangle to take care of condensation. This header arrangement not only satisfies all steam demand requirements, but provides adequate insurance against shut-downs from blown gaskets or other accidents.

All exhaust piping is below the engine room floor and is shown dotted in Fig. 6. A particular feature in this system is the method of connecting the exhaust piping from the generating units to the main exhaust header,

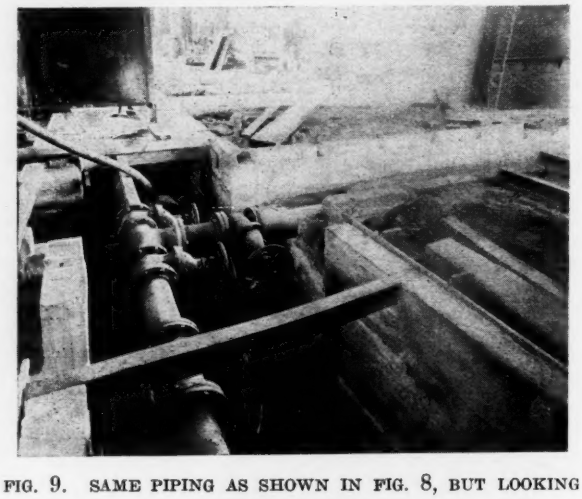


FIG. 9. SAME PIPING AS SHOWN IN FIG. 8, BUT LOOKING AT RIGHT ANGLES

by means of the Y arrangement shown. This arrangement was provided so as to reduce resistance losses to a minimum whether exhausting into the heating system or into the atmosphere, as the case may be.

The Heating System

The heating system at this plant is unique and is a new departure in this field. Whenever possible all heating is done with exhaust steam, but provision is made for admitting live steam into the system if the demand for exhaust steam should exceed the available supply.

Essentially, the system is comprised of two systems of piping as shown in Fig. 7; one, a 2-lb. trunk feeder

main, and the other an 11-oz. distribution loop. The 2-lb. feeder main is supplied with exhaust steam from the exhaust piping system under the engine room, and feeds into the 11-oz. main through reducing valves. All radiation units are directly connected to this 11-oz. main.

The exhaust steam main, as may be seen, emerges from under the engine room into the water wheel erecting building to an 18 by 12 by 12 by 12-in. cross, which feeds both branches of the feeder main and also connects the 2-lb. line to the 11-oz. line at this point through a 12-in. reducing valves. Photographs of the piping at this point are shown in Figs. 8 and 9. The 11-oz. line, although shown at the side in Fig. 7, is actually located directly above the 2-lb. feeder main, an arrangement which is adhered to throughout the entire installation. This is shown clearly in photographs, where the small line shown at the top is the 11-oz. distribution main in each case.

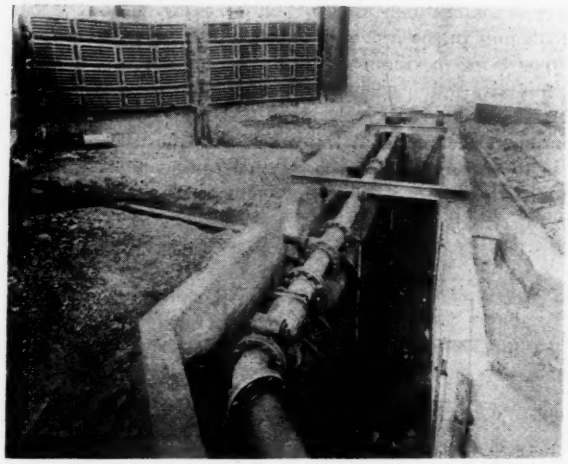


FIG. 10. VIEW OF HEATING MAINS IN TUNNEL, SHOWING TRUNK FEEDER, DISTRIBUTION MAINS AND RETURN LINE. FEEDER TO RADIATION UNIT ALSO SHOWN

As stated before, the 11-oz. distribution main is in the form of a closed loop or rectangle, cross connected at various points as shown, and connected to the feeder main at six points through reducing valves as indicated. The cross connections not only aid in equalizing the pressure throughout the system, but form a number of alternative methods of feeding steam to the radiators in case of accident to portions of the system. All radiation is direct and the units are all of the wall type. The various branches of the system in the pattern and carpenter shop and in the foundry, form loops of themselves and may be served from either the 11-oz. line or the 2-lb. feeder main.

Both piping systems as well as the condensate return line and hot water line run through a specially constructed concrete tunnel. All piping is supported on round rods suspended from I-beam cross-bars as shown in the photographs. Variations in length due to thermal expansion are effectively taken up by double sliding expansion joints securely anchored in place. Condensation in the lines is removed by traps spaced along the line at intervals which discharge into the separate condensate return line referred to above.

The entire system has been designed and installed with practically no slope so that the steam may be transmitted through the pipes in the loop system in either direction with equally good results.

Just inside of the engine room connection is made from the 2-lb. line to the main steam header, for the purpose of feeding live steam into the system when necessary. This connection includes a reducing valve which reduces the steam pressure from 140 lb. down to 1 or 2 lb. with entire success. Live steam is passed directly into the heating system, but exhaust steam is passed through a horizontal oil separator before entering the heating line. This is located just inside the engine room wall as shown in Fig. 6.

Much of the data used in the preparation of this article was secured through the assistance of Mr. Fishbough, maintenance engineer, who superintended the erection of the plant to whom credit is hereby extended.

Efficiency Somewhat Dependent on Light

IT ISN'T always an operative's fault when he doesn't work at full efficiency. Sometimes his environment makes it impossible.

Take the question of light, for example. Many factory owners, especially those operating in old buildings, feel they are doing their full duty by their workmen if they furnish them fairly good light.

But they are not doing justice either to their workmen or themselves. Safety engineers are against poor light because it increases accidents for which the boss pays under the Workmen's Compensation laws.

But aside from the safety feature, the cost to the factory owner of poor light, as determined by careful tests, is 12 per cent less production and 25 per cent more spoilage; also 25 per cent more accidents.

There are several ways of improving lighting. Rebuild the factory on modern lines. That would be expensive, but possibly justified by conditions. Another way is to install more artificial light or make better arrangement of existing lighting facilities. Still another more or less auxiliary expedient is to paint the interior of the work room with a special light reflecting paint. The paint cuts down the cost of artificial light by making less of it necessary.

From any angle it is viewed, this question of light is important, especially now that there is such insistent demand from all sides for greater efficiency and larger production.

NOON HOUR found the power house care-free. One of them was lecturing on the thermal value of the different coal. Murphy, sitting on the end of a truck, was evidently using soft coal, due to the enormous amount of smoke that ascended from the bowl of his pipe. He was an attentive listener, as was Mahoney. The lecturer had invited questions after he had finished.

Mahoney nudged Murphy and said: "Say, do ye understand the young mon?"

"I do thot."

"Then phat's the difference between hard and soft coal?"

"Six dollars a ton."

Bypasses in Power and Heating Plants

BYPASS CONNECTIONS AROUND VARIOUS PIECES OF APPARATUS REDUCES LIABILITY OF SHUTDOWN. BY CHARLES L. HUBBARD

INSTALLATION of a bypass for steam, water, or air in a new plant is a simple matter and may be provided at a comparatively small expense. The value of this, however, even though used at infrequent periods, may be many times that of the original cost, and often a single utilization of this device may prevent a costly shutdown of greater or less duration in a department or entire building.

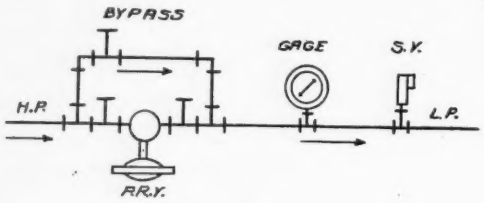


FIG. 1

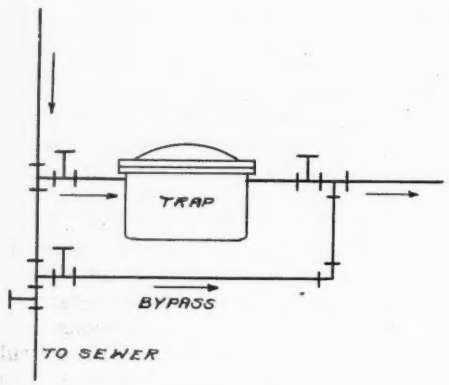


FIG. 2

FIG. 1. TYPICAL BYPASS ARRANGEMENT FOR REGULATING VALVE

FIG. 2. BYPASS AROUND A STEAM TRAP

While the bypass is more frequently provided than formerly, the writer has seen many instances where a reducing valve had been installed without the precaution of a bypass, so that in case the valve became stuck or otherwise injured, heat would necessarily be shut off from an entire building. Under this condition, it would be necessary to shut off the heating main until a temporary piece of piping could be fitted with the space occupied by the valve, after which steam could be admitted, in the quantity desired, by throttling the shut-off valve in the high-pressure supply.

With cut-out valves on each side of the regulating valve, and a bypass, it is a simple matter at any time to overhaul or remove it without interfering with the supply of low-pressure steam. A typical arrangement of this kind is shown in diagram in Fig. 1 and illustrates the necessary connections and equipment. A pressure gage should be connected into the main on the low-pressure side, for use in setting or regulating the reducing valve and also for use when supplying steam through the bypass when the former is out of commission. A small safety valve near the gage serves as a warning that the pressure is rising above the desired point when regulation is done by hand by means of the bypass, and also in case a chip or piece of scale gets under the seat of the regulator and prevents it from closing properly. Sometimes a whistle is attached to the safety-valve so that the warning may be heard at a greater distance. Other signalling devices may be employed if desired.

In general, the bypass around a pressure reducing valve is made much larger than necessary and it is not uncommon to see a 4 or 5-in. pipe and valve where one 1½ or 2-in. in diameter would be ample, and a valve of this size much easier to regulate by hand in case of repairs to the reducing valve. The bypass is best proportioned according to the maximum quantity of steam it is to supply, without reference to the heating main, and in this connection it may be said that much larger

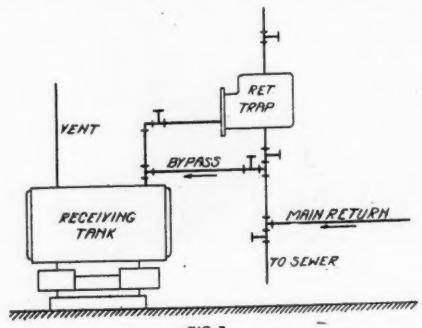


FIG. 3

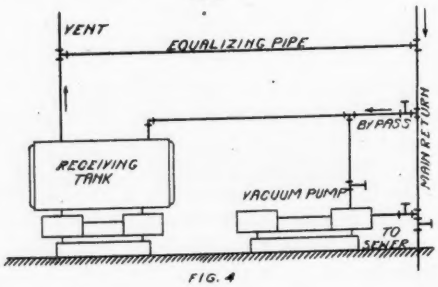


FIG. 4

FIG. 3. BYPASS CONNECTIONS FOR WATER LINE TRAP IN HEATING SYSTEM

FIG. 4. CONNECTIONS OVER PUMP, IN RETURN LINE VACUUM SYSTEM

reducing valves are frequently used than are either necessary or desirable. The accompanying table gives the proper size of bypass for different quantities of steam per minute. As reducing valves are largely used for heating, the second column bases the size of bypass on the number of square feet of direct radiation to be supplied.

Table showing proper size bypass for different quantities of steam per minute.

Pounds of steam per minute	Square feet of direct radiation	Diameter of bypass, in.
15	2,500	¾
25	4,500	1
40	7,000	1¼
70	12,500	1½
100	17,500	2
150	28,500	2½
200	40,500	3
300	63,000	3½

Bypass Around Traps

Another illustration of the bypass is its use in connection with a steam trap, as shown in Fig. 2. Traps are liable to get out of order and require cleaning, or the valve may need adjustment. With the pipe connections shown, the trap may be opened or entirely removed by simply closing the cut-out valves and opening the bypass just enough to care for the condensation. The arrangement in this case is such that the water may be simply bypassed around the trap or blown into the hot-well or sewer through the blowoff tank. In most cases, traps of this kind discharge with a vented receiving tank so that any steam which passes through the bypass with the condensation will simply flow out through the vapor pipe and therefore do no damage. If discharged to the sewer through the blowoff tank, any surplus steam will be disposed of in a similar manner. The bypass for a trap may be made one size smaller than the regular inlet and outlet connections.

Pipe connections, with bypass for a water-line trap in the main return from a heating system, are shown

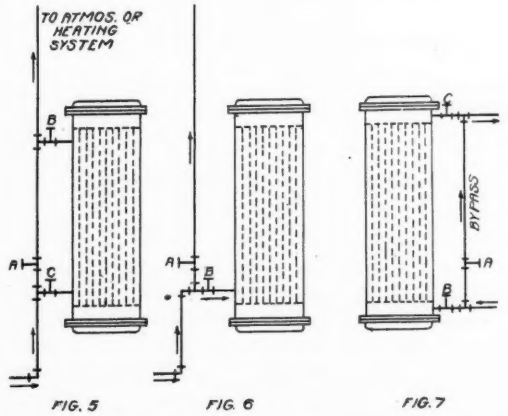


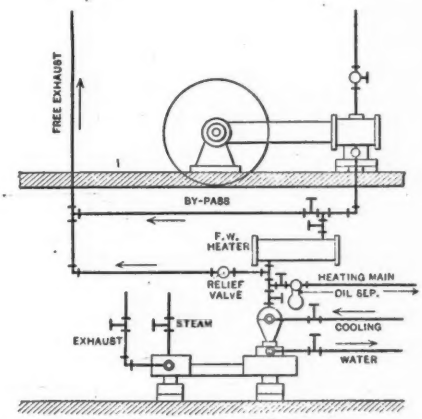
FIG. 5. CONNECTIONS FOR BYPASSING STEAM AROUND FEED-WATER HEATER

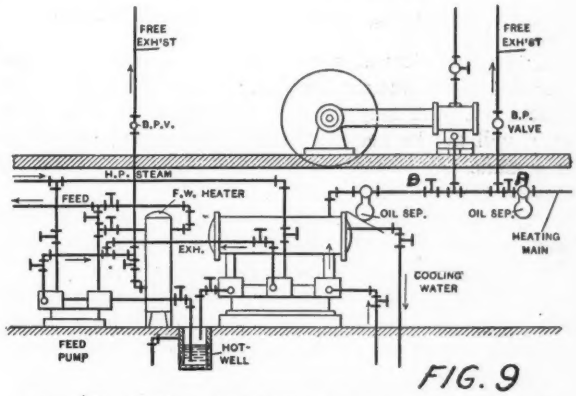
FIG. 6. FEED-WATER HEATER CONNECTED UP ON INDUCTION PRINCIPLE

FIG. 7. BYPASS CONNECTIONS ON HEATER FOR FEED WATER

in Fig. 3. This is similar in principle to the case just described, with connections both with the receiving tank and with the sewer.

In many plants operating on a return-line vacuum system, the elevations are such that the condensation will flow into the receiving tank by gravity in case anything happens to the vacuum pump. Such an arrangement is shown in Fig. 4, where all of the radiating surface is at least one story above the tank. In this case a bypass is provided over the pump, which may be used when repairs or adjustments are necessary to the latter during working hours. Under these conditions, the automatic return valves on the radiators will simply be discharging against atmospheric pressure instead of a slight vacuum, as is usually the case, a "balance" pipe being carried across from the receiver vent to equalize the pressure. In systems of this kind, it is generally customary to carry a steam pressure upon





FIGS. 8 AND 9. CONDENSER BYPASS ARRANGEMENTS

the radiation somewhat above that of the atmosphere so that the arrangement shown would work without difficulty. If, however, it was customary to operate on a slight vacuum, it would be necessary to raise the pressure to one or two pounds while the pump was out of commission, in order to discharge the condensation into the return mains against atmospheric pressure. In plants where the condensation must be lifted into the receiving tank, this plan would not work and duplicate vacuum pumps should be provided to guard against interruption of service.

Bypass on Feed-Water Heater

A feed-water heater illustrates another instance where bypasses are required both for steam, water, and drips. In case of the steam connections, it is usually customary to place the heater on the bypass, as the greater part of the exhaust steam flows directly to the heating system or outboard, only about 1/7 of the total amount being condensed in the heater under aver-

age conditions. A typical arrangement is shown in Fig. 5, in which valves B and C are opened wide and A throttled just enough to keep the heater steam-filled. In general, all three valves may be kept wide open, as any lack of steam in the heater will produce a slight drop in pressure which will draw in steam from the main. If, however, there is any tendency to suction by the steam passing by the heater connections, it may be overcome by slightly throttling valve A as previously noted. In case of repairs to the heater, or at other times when for any reason its use is not necessary, valves B and C may be closed and A opened wide.

Figure 6 shows a heater connected up on the "induction" plan with a single inlet. With the arrangement shown, it is evident that sufficient steam will be *driven* into the heater to keep it filled, while any surplus will

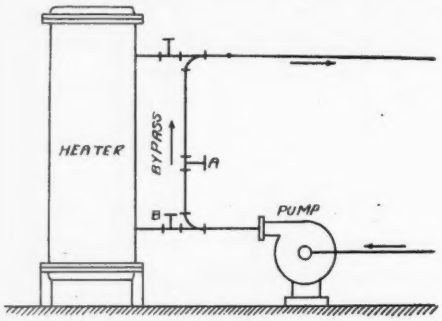


FIG. 10. BYPASS ON FORCED HOT WATER HEATER

pass up the vertical pipe through valve A. In case there is any tendency for the pressure to drop in the heater, valve A may be throttled slightly. This, however, will not be necessary if the connections are properly made. The heater in this case is cut out by simply closing the valve B.

Typical bypass arrangements for the feed-water connections with a heater are shown diagrammatically in Fig. 7, in which A is the bypass valve and B and C the cut-out valves. The action is clearly indicated by the arrows and needs no description. This may be carried out in principle to meet a variety of conditions.

Condenser Bypass Arrangement

Bypass arrangements for condensers are shown in Figs. 8 and 9, the first referring to a jet condenser and the second to a surface condenser. In Fig. 8, the connections are such that the exhaust from the engine may be turned directly into the outboard riser through the bypass or passed through the feed-water heater to the condenser which is located directly below it. Between the heater and condenser there are two connections, one at the left, leading through a relief valve to the free exhaust, and one at the right, leading to the heating system through an oil separator. Such an arrangement as this is adapted especially to cases where the exhaust steam is utilized for heating purposes during the winter and where the engine is run condensing through the summer to secure greater steam economy. By closing the valve first above the condenser cone, we have the usual exhaust heating system, in which the exhaust passes directly to the heating main through the oil separator. Any surplus exhaust not required, passes outboard automatically through the relief valve at the left when the pressure rises slightly above the normal. A reducing valve, not shown in the drawing, supplies live steam to supplement the exhaust when needed. When the plant is to be run condensing, it is only necessary to close the valve in the heating main and open that leading to the condenser. The relief valve is required in either case.

The principle of the layout is much the same in Fig. 9, although the piping arrangement is different. Here the exhaust may either pass outboard through the back-pressure valve, or to the heating main, or to the condenser as desired. By closing valve A and opening B, the plant becomes condensing, while reversing this arrangement changes into a noncondensing low-pressure heating system. This constitutes a "bypass," although the layout would hardly be recognized as one. In one case, the heating system is bypassed, while in the other the condenser is cut out.

Bypass Connections on Forced Hot-Water Systems

A bypass is useful in forced hot-water systems for regulating the temperature of the water without vary-

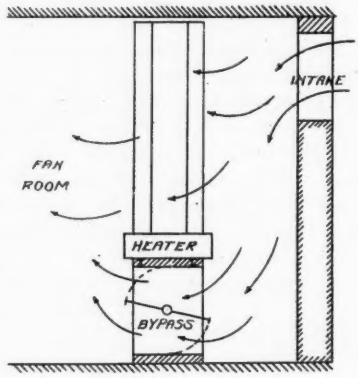


FIG. 11

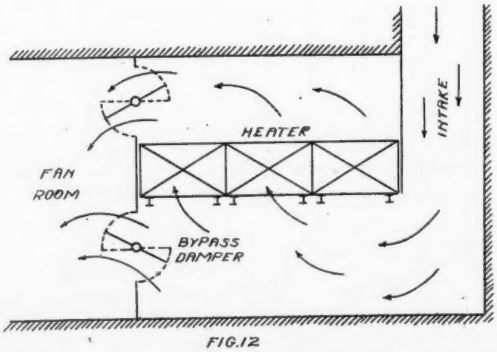


FIG. 12

FIGS. 11 AND 12. TYPICAL HOT BLAST HEATER BYPASS ARRANGEMENTS

ing the pump speed or interfering with the steam valves. This is made clear in Fig. 10, where it is evident that the temperature of the water passing into the heating main may be lowered by opening valve A and bypassing a portion directly into the main without its reaching the heater. Small changes in temperature may be made by simply varying A, while for greater ones it will be necessary to throttle valve B after A has been fully

opened. With this method of regulation, it is not necessary to touch the steam valves, as the steam supply to the heater is taken care of automatically by the combined action of the pressure-reducing and back-pressure valves.

In general, it may be said that any piece of steam or water equipment which is likely to need repairs should be bypassed, provided the plant may be operated *temporarily* in this manner. This applies to cases such as a reducing valve where the pressure may be regulated by hand by means of a throttle valve for the limited time required to make repairs on the automatic regulator. In case of a boiler feed pump, on a high-pressure system, a bypass would evidently be of no use and a duplicate pump or relay should be provided. On a heating system, where the condensation was returned by a return trap, the pressure would probably be such that the boilers could be fed through a bypass from the city mains and the condensation turned into the sewer through the blowoff tank while repairs were

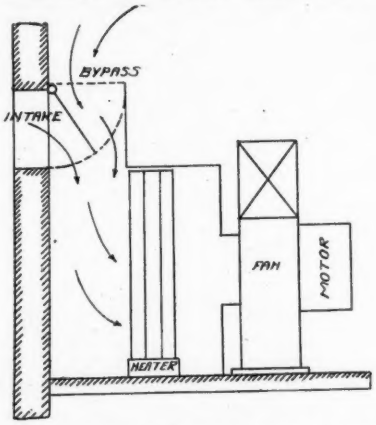


FIG. 13. BYPASS FOR AIR SUPPLY SYSTEM

being made to the trap. Devices like steam and oil separators require very little attention in the way of repairs and do not need to be bypassed. Any cleaning necessary may be done out of working hours.

BYPASSES FOR AIR

BYPASSES for air are common in connection with ventilating plants and hot-blast systems and in many cases would prove both convenient and economical where they have not been provided. One of the most common uses is in connection with a hot-blast heater for varying the air temperature, within certain limits, without manipulation of the steam valves. Two typical arrangements of this kind are illustrated in Figs. 11 and 12, the first being applied to a pipe heater of the usual type and the second to a cast-iron heater suspended between the floor and ceiling. In cases of this kind the heater is usually divided into a certain number of valved sections by means of which a rough or approximate regulation may be made according to the season of the year, and daily or hourly fluctuations cared for by variations in the position of the bypass damper. In the average case, the steam and return valves are manipulated by hand while the bypass damper is operated automatically by means of a graduated hot-air thermostat.

Bypass dampers may be installed to advantage in shops and other industrial buildings where the original system has been planned to take the entire air supply from out of doors. An arrangement whereby varying proportions of air, up to the full supply, may be taken from inside the building will greatly increase the operating economy where live steam is required at any time for heating purposes and at the same time produce equally good results as far as ventilation is concerned. Such a scheme is shown in Fig. 13, in which case, with the bypass damper in a horizontal position, all of the air will be taken from outside. By dropping it to a vertical position, the outside opening will be closed and all of the air will be drawn from inside the building.

In many cases the upper part of a high room or monitor roof building becomes overheated while it is cool near the floor. By drawing a considerable portion of the air from a point near the ceiling or roof and discharging it downward at a fairly high velocity towards the floor, the temperature of the room will be equalized and conditions much improved, while the quantity of steam required has been reduced. This can, of course, be done only in rooms of good height and where the cubic contents of the room is fairly large per occupant, a condition, however, which applies to most machine shops and similar industrial buildings of modern construction. The older theory that large volumes of outside air were necessary to keep down the percentage of carbon dioxide has changed somewhat in later years and it has been found by investigation that temperature and humidity regulation, together with a brisk air movement, are of equal or greater importance as compared with air volume.

Danger in Heel Plates

BY J. B. DILLON

THAT the heel plates worn by many people to rebuild shoe heels contain a certain element of danger was brought out by conversing with a conservative man, one who has worn these little plates for years.

"While I wore the small plates, I did not find any trouble, other than the fact that they soon wore down, or dropped off early. Then I tried the larger ones. They held on like metals that are welded; but while walking briskly and attempting to stop on a curbing to avoid a speeding automobile, I slipped off and the sudden jar as my foot struck the gutter produced a stinging pain in my ankle. That it was not sprained I attribute to the fact that there were only a few inches between the top of the curb and gutter. Only a few hours thereafter in turning a corner, two women crowded me and in attempting to give the ladies the right of way I tried to slip around them, my foot slipped on the tiling and a soft alpine hat is all that saved me from being knocked unconscious as my head struck an iron pillar. The impact was so great that for a few minutes I was dazed. I shall either have my heels rebuilt with leather in the future, or better still have a rubber heel placed."

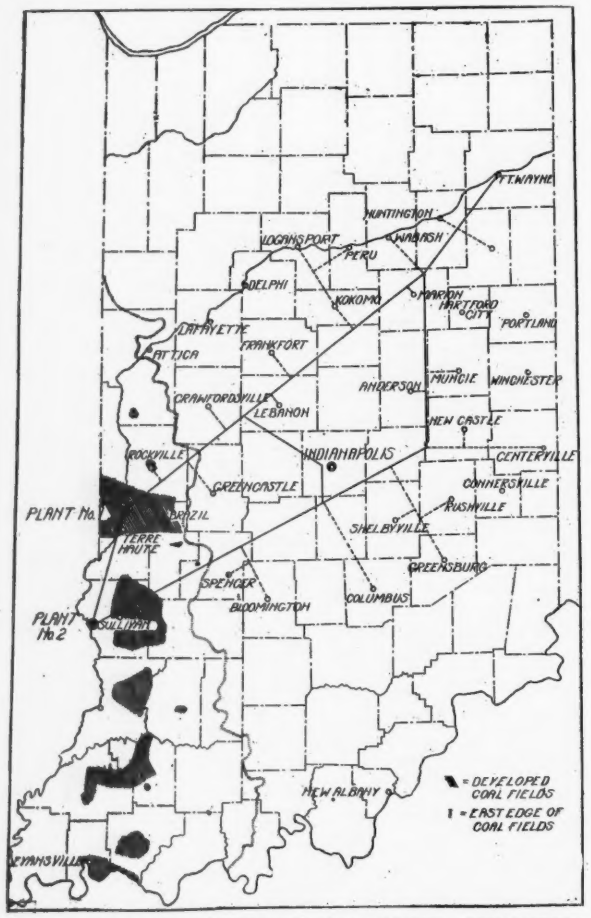
This information is passed along because it is brimful of good reasoning and as many of us are forced to use ladders, stand on iron and steel beams, a slip at this time might mean loss of life or forever a cripple.

THE MAN who performs the most useful work at hand never lacks employment.

Super-Power Stations for Central Indiana*

GENERAL OUTLINE OF THE NEEDS, ADVANTAGES AND POSSIBILITIES OF A SYSTEM OF GENERATING STATIONS, LOCATED IN COAL MINING DISTRICTS, SUPPLYING POWER TO ENTIRE CENTRAL PART OF STATE. BY FREDERICK L. RAY

IN PRESENTING this paper on Super-Power Stations and High Voltage Transmission System, I want to give credit to John A. Stevens of Lowell, Mass., for many of the ideas here brought forward. It was due to his writings on this subject that I became interested and was induced to present this plan for fuel conservation for the central portion of the State of Indiana. The map accompanying this sketch shows the approximate location of the power plant on the Wabash River and



MAP OF INDIANA SHOWING PROPOSED POWER DISTRIBUTING SYSTEM

the high voltage transmission lines across the state with branch lines carrying a lower voltage distributing to the larger cities of the state.

While the project we now present is primarily one caring for the power supply of central Indiana, yet the plan could be extended to cover practically all of Indiana and the eastern half of Illinois. There is condensing water in the Wabash River for steam power plants generating hundreds of thousands of horsepower by using all the water at one point and then locating another plant far enough below, so that the water will have cooled by the time it reaches the next plant, being careful to keep the maximum demand safely below the minimum flow of water in the river.

A project of this kind cannot be considered unless there is an abundance of water for condensing purposes and at the points selected, there is a never failing supply for at least 150,000 kw. The Wabash River at Terre Haute has a minimum flow of 300 cu. ft. per sec. and an ordinary minimum flow of 2000 cu. ft. per sec. With this flow of water and a plant using 10 lb. steam per kilowatt-hour, there is possible a generating capacity of 150,000 kw. in each plant. Several plants of this size could be erected in this coal field, on the river, between Terre Haute and Vincennes.

The conservation of our coal is of so great importance, that in a case such as this, where more than one-half of the coal now burned in a certain district can be saved, then it ought to be saved. Some day the law of the land will say to you that you must not use, to generate current, more than 2 lb. of coal of a specified heat content per kilowatt-hour. If it should say that to you today, what would you do? There is not one plant in the state of Indiana that is doing that well. Some of the smaller plants are now using from 7 to 8 lb. of coal per kw.-hr. The average is about 4.5 lb. per kw.-hr.

The table below shows the approximate kilowatt-hours generated per month, coal consumed and the coal per kilowatt-hour for some 25 cities of central Indiana:

Town—	Output in kw.-hr. per month	Coal consumed, tons	Coal per kw.-hr.
Indianapolis	15,191,052	28,780	3.77
Terre Haute and Brazil	3,710,950	7,792	4.19
Crawfordsville	680,660	2,318	6.81
Ft. Wayne	4,767,569	9,516	3.99
Peru and Wabash	555,293	2,266	8.16
Logansport	692,362	2,519	7.27
Marion and Kokomo	2,280,400	6,656	5.83
Richmond	1,289,200	3,068	4.76
Anderson	4,493,100	8,801	3.92
Huntington & Bluffton	795,920	2,510	6.31
Vincennes and Sullivan	2,321,526	3,721	3.20
New Castle and Muncie	5,289,960	8,512	3.21
Columbus	130,510	479	7.34
Lafayette and Frankfort	1,465,233	7,081	9.66
Martinsville and Greencastle	308,790	915	5.92
Rushville and Greensburg	52,000	500	...
Total	44,024,523	95,434	

This output represents a daily output of 1,467,484 kw.-hr. or an average kw. load of 61,141. If we have an average load factor of 40 per cent, then the peak load would be 152,800 kw. delivered to the consumers.

The coal consumption for the whole state of Indiana for public utility companies of 100 kw. capacity or more amounted to 1,534,039 t. (referred to U. S. Geological Survey report) for the first nine months of 1920, or an average consumption of 170,448 t. per month. Of this amount 95,434 t. or 56 per cent of total for the state was used in the 25 cities in the central part of state

*Paper read before the Indiana Engineering Society.

within the boundaries of east and west state lines and the 39th and 41st degrees north latitude.

During the first 9 mo. of 1920, the average consumption of coal per kilowatt-hour was 4.42 lb. for the 25 cities as shown above. During this time there was generated an average of 44,024,523 kw.-hr. per month in this district, then with a coal consumption of 190,868,000 lb. we have 4.34 lb. per kw.-hr.

This current could be generated in a modern plant for 2.12 lb. coal per kw.-hr. including 30 per cent transmission losses up to the consumer, thereby, saving 2.22 lb. of coal per kw.-hr. $44,024,525 \times 2.22 = 97,734,445$ lb. 97,734,445 lb. = 48,867 t. coal saved per month. 48,867 t. at $3 per ton at the mine means a saving of $146,601 per month. The freight saved on 95,434 t. per month, the total used in this district at an average rate of $1.50 per ton amounts to $143,151, or a total saving in freight and coal of $289,752 per month or $3,477,024 each year. The coal saved each year would be $12 \times 48,867$ t. = 586,404, or approximately 600,000 t.

According to data given me by the Indiana Department of Geology, the amount of coal available in Indiana where the power stations would be located would be as follows, I have made some calculations to bring the figures up-to-date.

County—	Estimated total tonnage of workable coal left according to report of 1908.	Estimated total tonnage of workable coal left Jan. 1, 1921, based on estimated amount mined since 1908.	Total mined since 1908 to 1920, inclusive, estimated from report of year 1919 of Indiana Industrial Board, 13 yr.
Park	425,000,000	1,300,000	423,700,000
Vermilion	600,000,000	39,000,000	561,000,000
Vigo	1,500,000,000	78,000,000	1,422,000,000
Sullivan	4,000,000,000	39,000,000	3,961,000,000
Total	6,525,000,000		6,367,700,000

These figures would indicate that there will be coal available near these great power stations to supply them with fuel for many generations and enable them to generate all the power needed for central Indiana.

There would be two independent plants of 150,000 kw. each, one north of Terre Haute in Vigo County, and the other south of Terre Haute in Sullivan County, so connected electrically that each plant could help the other when the need occurs. Both would be erected on the Wabash River, of course, and as close to the coal producing field as possible so that coal haulage would be reduced to a minimum. With plants located at these points, in the heart of a great coal field and on a never failing stream of water they would be able to generate current for a minimum amount of coal, and at a minimum cost per kilowatt-hour.

The arrangement of equipment for such a plant would require a turbine room in which all the turbines could be located, with a boiler room consisting of five sections with division walls between each group of boilers making five independent boiler rooms, yet connected with piping so as to be able to help one another, yet isolated in case of accident.

The boilers for a plant of this size would be at least 2500 hp. each and when operated at 200 per cent rating would give 5000 hp. Three boilers of this size operating at 200 per cent rating would furnish the steam for one 35,000 kw. turbine unit. It would be necessary to have an extra boiler in each section of plant so that each section would have four boilers with one in reserve when turbine was running at normal load. Steam to be generated at 250 lb. pressure per square inch and superheat 200 deg., giving a total temperature of 605 deg. F. Each boiler to be equipped with all steel superheaters and mechanical soot blowers. Enough all-steel economized surface would be installed with each boiler to raise the feed water temperature to a point within 25 deg. F. of the temperature due to the steam pressure.

All the walls of the boiler from a point just above the grate should be absolutely air-tight and also, insulated against heat loss. All doors through walls giving access to boiler should be provided with a gasket, so that they can be made air-tight.

Each boiler would be equipped with duplex underfeed stokers with enough retorts to give 200 per cent rating of boiler at normal rate of feed through retort, thereby, insuring the highest possible efficiency, at the same time having a large bed of coal in furnace ready for emergency demands for steam. The boiler should be set high enough to give a combustion space equal to at least 15 cu. ft. of space to 1 sq. ft. of grate surface.

One stack would serve two boilers with smoke flue so arranged that the economizer could be bypassed at any time. Stack would be of brick 250 ft. high.

Provisions would be made on each boiler for the burning of powdered coal to the extent of 50 to 200 per cent normal demands. Then in emergency the output could be increased to 400 per cent without crowding the stoker. The mixing of the flame from the powdered coal with that of the flame from coal on stoker would greatly improve combustion. One of the great troubles with powdered coal burning, that of ash removal, would be overcome, for the ashes from the powdered coal would fall upon the ash and refuse from the stoker and could be readily dumped to ash pit and removed.

All fuel used, both on stoker and pulverized coal would be accurately weighed and the output from boiler measured so that definite knowledge would be at hand as to the efficiency of the boiler.

Such a combination of mechanical stokers and pulverized coal would give a high percentage of efficiency for the whole cycle of operation.

The turbine generators for this plant would be rated at 35,000 kw., 100 per cent power factor, and deliver 60-cycle, three-phase current at 13,200 v. There would be required five units, one of them a stand-by, with four in service all the time. Each turbine would be connected to its individual boiler plant, with the piping so connected as to interchange steam between the several plants.

The current would be generated at 13,200 v. and with step-up transformer raised to 110,000 v. for the high-voltage transmission. At distributing points, the voltage would be stepped down to 6600 or any convenient voltage required. In most cases, the step down would be to a voltage now in use in the present generating stations. A study of the map will indicate that it is planned to have a double ring system of high voltage transmission lines, with a cross connection between the plants.

The first loop would be a duplex, three-phase line, with a capacity large enough to carry all the load on either one of the duplex lines with all of Indianapolis load imposed. The second would be the loop beyond Indianapolis taking in Richmond, Anderson, Muncie, Marion, Ft. Wayne, etc., which would require a smaller wire. With such a ring system of transmission a complete breakdown of service would be next to impossible. The table given below shows the approximate miles from station to principal cities.

Between Power Stations	38 mi.
North plant to Indianapolis	78 mi.
South plant to Indianapolis	96 mi.
South plant to point near Newcastle	120 mi.
South plant to junction point north of Marion	174 mi.
North plant to junction point north of Marion	120 mi.
Marion to Ft. Wayne	40 mi.
North plant to Ft. Wayne	160 mi.
South plant to Anderson	144 mi.
South plant to Muncie	158 mi.
South plant to Richmond	156 mi.
South plant to Columbus	114 mi.
North plant to Kokomo	100 mi.
North plant to Logansport	120 mi.

This project being one of coal conservation and in the interest of all the people, the preliminary work of survey and investigation should be carried on by the state. A plan that would save each year nearly three-quarters of a million tons of coal is one that will enlist the support of all patriotic men and women, and the state of Indiana should appoint a commission to investigate the plan and show to the people the enormous waste that is now going on and to point the way for a solution. The cost of building the necessary large power plants that can generate at maximum economy, located at the mouth of the coal mine and on a river site, and of building the high voltage transmission lines covering the state should also be a subject for report by this commission.

When these plans are worked out, presuming that their report is favorable to the plan, then there is no question but that the business men of the country will respond to the call for financial support to put into actual service a plan of so great importance to fuel conservation.

With such a system in operation, a great burden would be lifted from the railroads, so that equipment could be used for other purposes. To handle 600,000 tons of coal per year would require 12,000 cars and about 400 locomotives, or 400 trains of coal of 30 cars each. If each car requires eight days to make the round trip from mine to consumer and back, then we would require for the year's business 308 cars working six days per week.

The railroad in this district should be electrified as quickly as possible, but not until all other industries have been taken care of. A steam locomotive wastes two-fifths of the coal burned as compared with an electric locomotive, therefore, the electrification of the railroads is of great importance.

To conserve the coal supply should be the principal aim and object of such an installation of power plants and transmission lines as this; however, there is no reason why such a project should not be a permanent and good investment if properly designed, equipped and operated. With our present knowledge of design and equipment of power plants and transmission lines, there would be no excuse for experiment, for every part of the system could be laid out from design we now have, so that it would operate successfully from the very start.

Control of Salt Content in Boiler Water

Its Effect on the Life of Boilers. By Claude C. Brown

FOR many years it has been a known fact that when the water in a boiler becomes salty to a certain degree, boiler tube troubles begin to appear. When the Na Cl content exceeds 300 parts per 100,000 of the boiler water, the tubes start to blister and burn out, irrespective of whether or not they contain scale. Hence it is obvious that it is necessary to know the degree of salinity of the water in all parts of the boiler at all times.

The problem that now presents itself is that of obtaining a correct sample of the water in the boiler. The question arises as to whether or not the salinity of the water is uniform throughout the boiler, or whether under operating conditions some parts of the boiler contain water of greater salt content than others.

In a certain type of three-drum water-tube boiler, the water is fed into each of the three drums at the front end. From here it circulates to the rear end of the drum, down through the circulating tubes and back up the boiler tubes into the drum again.

The feed-water line which feeds the boiler follows along the top of the casing on the outer side of each battery until at the front wall it is carried along the boiler front just under the drum heads toward the center of the battery. Branches are taken off at each drum and the line terminates in the branch to the third or inner drum. Hence the feed water travels from the outer toward the inner drum, the first, or outside, drum being the first drum to be supplied, and also this is the drum to which the water column is attached.

It has been shown, from an innumerable number of tests made from the water of the three drums of such boilers, that this outside or water-column drum, at all times when the boiler is under steam, contains the freshest water of the three drums. In other words, the salinity of the water in the three drums increases in the direction of flow of the feed water; the first drum to be fed is the least salty, while the last contains the greatest amount of salt.

Right here is where the importance of proper sampling comes in. It has been the practice at practically every plant to sample the boiler water from the water column drain and to assume that this is a sample of the boiler water as contained in all parts of the boiler. This assumption is a serious mistake, for the reason that the boiler water taken from the column drain is a sample of the water in the drum to which the water column is attached, namely, the first drum to be fed, and is consequently the freshest water in the boiler.

From all observations it would appear that the greater part of the feed water which enters the boiler is introduced into the first drum, from which it travels

down through the mud-drum and back up into the other drums.

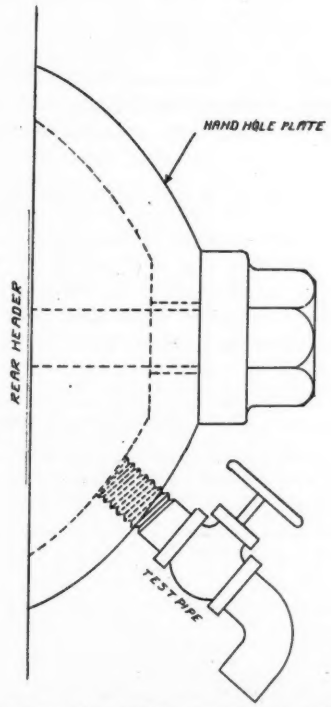


FIG. 1. METHOD OF INSTALLING SAMPLING COCK IN HAND-HOLE PLATE

The salinity or, as it is sometimes termed, the "density" of the three drums in parts per 100,000 of Na Cl has varied in certain cases as follows: No. 1, 75; No. 2, 200; No. 3, 500; and in many cases the difference is even more marked.

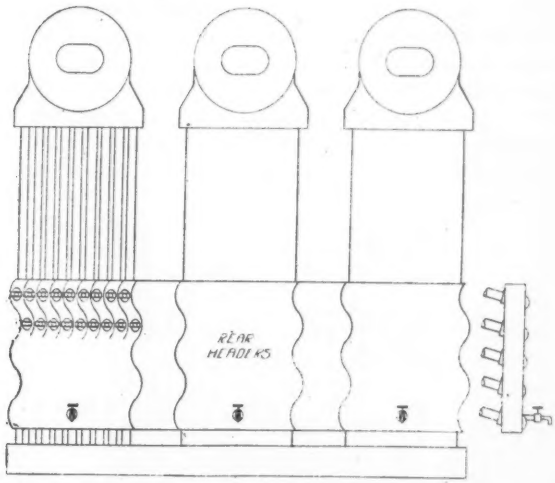


FIG. 2. VIEW OF REAR OF BOILER SHOWING POSITION OF SAMPLING COCKS

From the foregoing, it is obvious that, inasmuch as the water in the first drum is always less saline than that in the other drums, and also that this difference in salinity is more marked, the longer the boiler has

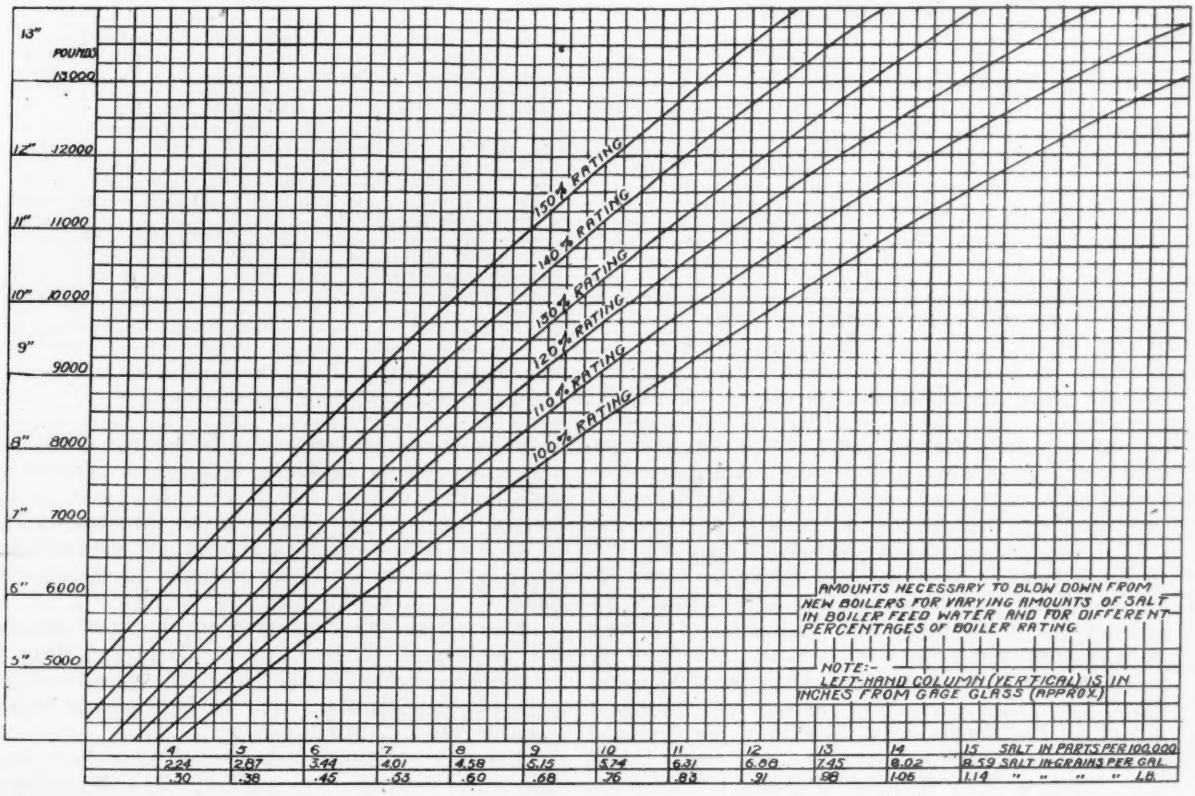

13" POUNDS 13000
12" 12000
11" 11000
10" 10000
9" 9000
8" 8000
7" 7000
6" 6000
5" 5000
150% RATING
140% RATING
130% RATING
120% RATING
110% RATING
100% RATING
AMOUNTS NECESSARY TO BLOW DOWN FROM NEW BOILERS FOR VARYING AMOUNTS OF SALT IN BOILER FEED WATER AND FOR DIFFERENT PERCENTAGES OF BOILER RATING
NOTE:- LEFT-HAND COLUMN (VERTICAL) IS IN INCHES FROM GAGE GLASS (APPROX.)
4 5 6 7 8 9 10 11 12 13 14 15 SALT IN PARTS PER 100,000
2.24 2.87 3.44 4.01 4.58 5.15 5.74 6.31 6.88 7.45 8.02 8.59 SALT IN GRAINS PER GAL
.30 .38 .45 .53 .60 .68 .76 .83 .91 .98 1.06 1.14 " " " " LB.

FIG. 3. CHART SHOWING AMOUNT OF BLOWDOWN NECESSARY FOR VARYING DEGREES OF SALINITY AND VARYING BOILER RATINGS

been in service after filling or cleaning, it is not correct to assume that any sample of water taken from the water-column drain is a representative sample of the water in the boiler.

Improved Method of Sampling

In order to obtain a correct sample of the water in each of the three drums, the following scheme has been successfully tried out in a large Western plant. A hole was drilled and tapped into the center handhole plate under the center of each drum and in the second row of tubes from the bottom at the back of the boiler. Into this hole was permanently installed a ⅜-in. nipple and valve, as shown in Figs. 1 and 2. From this sample pipe, a sample of water can be taken at any time that the boiler is in operation and will be a true sample of the water in the particular drum and section of tubes from which it is drawn. From these samples the condition of the water in any section may be ascertained at any time.

The importance of this method of sampling will be seen at once, as it has a direct bearing upon the life of the tubes, the equalizing of the work performed by each section of the boiler and also a decided bearing upon fuel economy.

In the above-mentioned plant, where ten 600-hp. and four 200-hp. boilers are run continuously at 150 per cent of rating, the sample tubes have been installed and daily samples are taken from each drum of each boiler. The salinity of each of the three drums of each boiler is kept fairly uniform and down below 300 parts per 100,000, by blowing an amount out of each drum, corresponding to the salinity of the water as shown by test of that particular drum.

The direct result of such procedure, together with careful supervision of the treatment of boiler feed water, has resulted in an absence of scale and has been the primary reason why not a single boiler tube was lost from February, 1920, to December, 1920, although all of the boilers have been run at an average of 150 per cent of rating and at times well above that figure.

Checking Blowoff Procedure

At this point it might be interesting to note that the accurate sampling and analysis of the water in the boilers gives an excellent check on the quantity of water that is blown off each day from each boiler. Knowing the analysis of the feed water, the rate of evaporation of the boiler and the analysis of the water in the boiler, it is an easy matter to calculate the amount blown off and check it against the drop in the glass or the amount shown by the blowoff tank. At plants where no blowoff tank is installed and no way of measuring the blowoff is provided, this method is especially valuable.

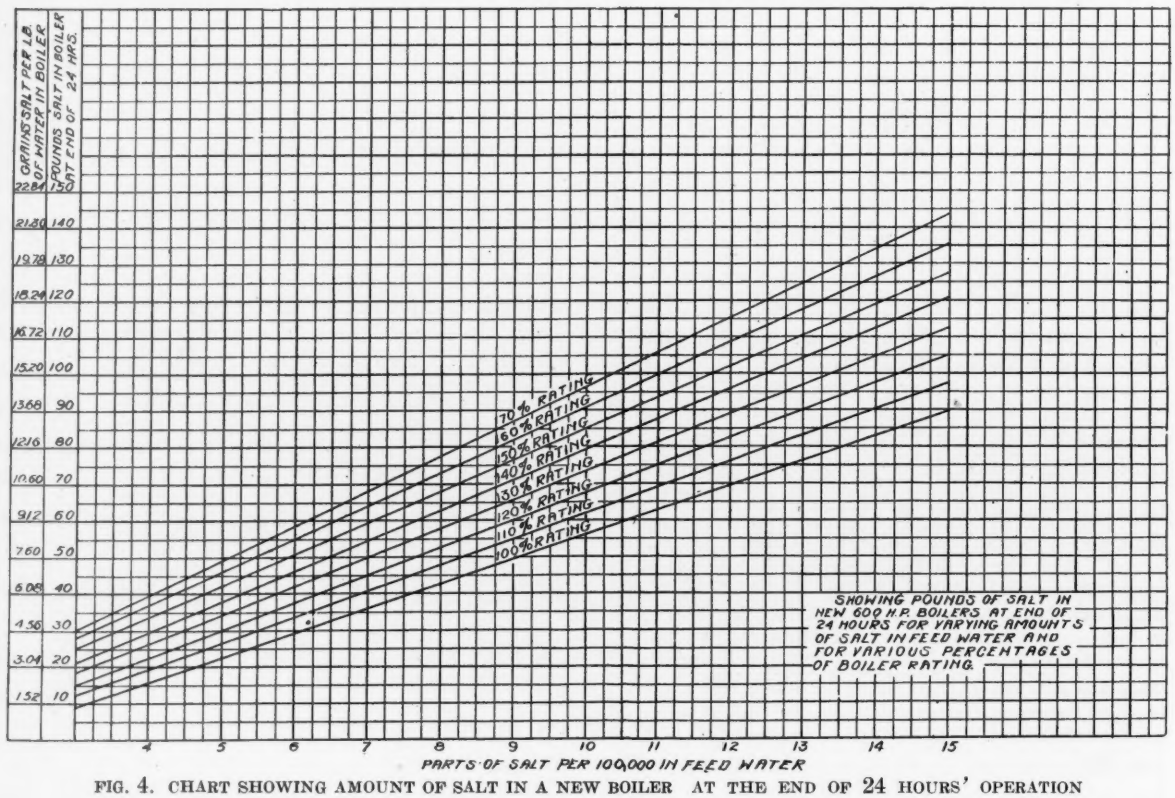

GRAINS SALT PER LB. OF WATER IN BOILER
POUNDS SALT IN BOILER AT END OF 24 HRS.
2284 150
2130 140
1978 130
1824 120
1672 110
1520 100
1368 90
1216 80
1064 70
912 60
760 50
608 40
456 30
304 20
152 10
70% RATING
60% RATING
150% RATING
140% RATING
130% RATING
120% RATING
110% RATING
100% RATING
SHOWING POUNDS OF SALT IN NEW 600 H.P. BOILERS AT END OF 24 HOURS FOR VARYING AMOUNTS OF SALT IN FEED WATER AND FOR VARIOUS PERCENTAGES OF BOILER RATING.
4 5 6 7 8 9 10 11 12 13 14 15
PARTS OF SALT PER 100,000 IN FEED WATER

FIG. 4. CHART SHOWING AMOUNT OF SALT IN A NEW BOILER AT THE END OF 24 HOURS' OPERATION

Figure 3 shows a curve from which can be obtained the quantity of water to be blown from each drum in pounds or in inches on the water-gage glass for different amounts of Na Cl in the boiler feed-water at ratings varying from 100 to 150 per cent.

Figure 4 is a curve which shows the pounds of Na Cl that will be contained in a 600-hp. B. & W. boiler at the end of 24 hr. when operated at ratings from 100 to 170 per cent.

Hydraulic Turbines for Electric Generators

IMPULSE AND REACTION TURBINES. METHODS OF CONTROL AND FACTORS DETERMINING SUCH METHODS OF CONTROL. BY L. W. WYSS

TURBINES USED in modern hydroelectric plants may be divided into two classes: First, the reaction or Francis turbine which has been considered a low head turbine, but has been used for heads close to 700 ft.; second, the tangential turbine, also called the Pelton or impulse wheel, which is adapted for high heads or for silt laden water.

REACTION TURBINES

REACTION TURBINES may be set in open penstocks or enclosed in steel or concrete casings, which is the usual practice for high heads where an open flume would be impractical. The latest practice is to set them in a volute or spiral casing. At low head installations, the vertical shaft type is preferable and a spiral casing may be moulded in the foundation of the power house.

Horizontal turbines are built with single or double runners. The double runners may discharge into one or into separate draft tubes. Double runner turbines are often in tandem, as many as four double runner turbines being connected that way at some open penstock plants.

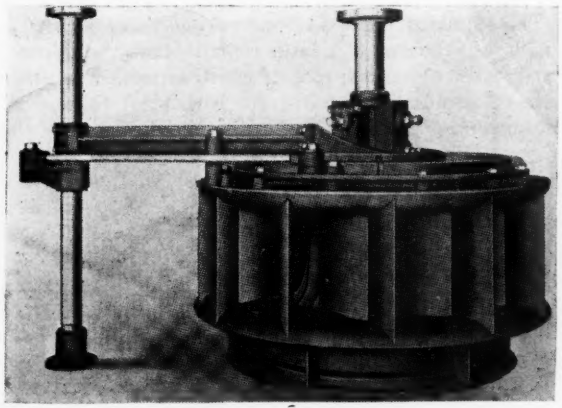


FIG. 1. TYPICAL WICKET GATE ARRANGEMENT

Vertical turbines seldom have more than two runners. These exceptions are at plants where a third runner is used during floods when the high tail water curtails the output of the double runners and the third one is used to keep the generator loaded.

As it is much more convenient to set the turbines above the tail water, draft tubes are used to regain the head which is lost by setting the turbines at this height. They discharge the water below the tail water elevation so that a vacuum forms into which the water discharges after leaving the turbine runners.

Wicket gates are used to control the speed or output of turbines. Figure 1 illustrates a typical wicket gate arrangement. This picture shows the gate operating ring, which opens and closes the gates when the gate shaft turns. This gate operating mechanism is called the enclosed or submerged type and is used more extensively at low head plants than at higher head installations where, with few exceptions, the gate operating mechanism is exposed and the only moving parts submerged are the runner, shaft and wicket gates. Figure 2 shows the gate mechanism of an 8500-hp. turbine. The spiral casing has not been bolted in place and so this gives a view of the wicket gates also. Packing glands are provided on each wicket shaft.

When a number of turbines are coupled in tandem, a long gate shaft is necessary and it is sometimes found advisable to divide the load on two gate shafts and perhaps two governors. This arrangement is excellent for carrying part load, as the water may be kept closed off from half of the turbines while the others carry the load efficiently, which would not be the case if all turbines were using water at small gate opening.

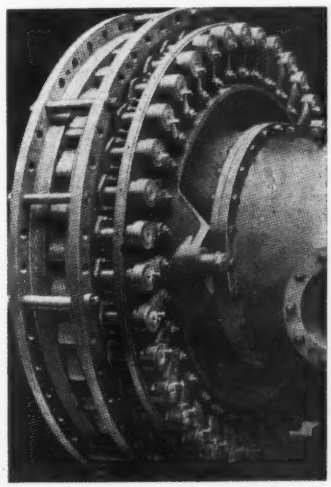


FIG. 2. GATE MECHANISM FOR AN 8500-HP. TURBINE

To avoid high pressures in long pipe lines where the turbine gates are closed quickly, pressure regulators are employed. They are usually connected directly to the turbine gates and are therefore called governor operated pressure regulators. Pressure regulators which operate independently by responding directly to the pressure variation in the pipe line are also used and are called pressure operated pressure regulators. They are similar to safety valves, except that there are refinements to prevent water hammer. Figure 3 shows a 6400-hp. 320-ft. head turbine equipped with a 30-in. governor operated, pressure regulator, which allows only 5 lb. pressure rise in the pipe line with full load thrown off. A good view of the gate operating mechanism is shown and also the regulator connecting rod. Notice the gate opening indicator attached to the gate ring, also the vertical pipe which provides water through the regulating valve to the balancing piston, relieving the thrust bearing of the end thrust encountered with single runner turbines unless they are of the double discharge type.

TANGENTIAL TURBINES

THESE TURBINES are adapted for heads from about 700 ft. up or for lower heads using silt laden waters.

The buckets are made of iron, steel or bronze, which are removable and can be replaced quickly in case of wear or breakage. These water wheels are made with single or double runners and there are two different methods of controlling their speed and power output.

The water wasting method of control is advantageous for hydro plants where the river flow must be kept constant for irrigation projects, for a down-stream plant, for the safety of the penstock or to prevent the overflowing of a flume. Deflecting hoods are used to deflect all or part of the water discharging from the nozzle, or the nozzle itself may be moved to deflect the stream away from the wheel buckets. There is also a rotating nozzle built which deflects the jet of water.

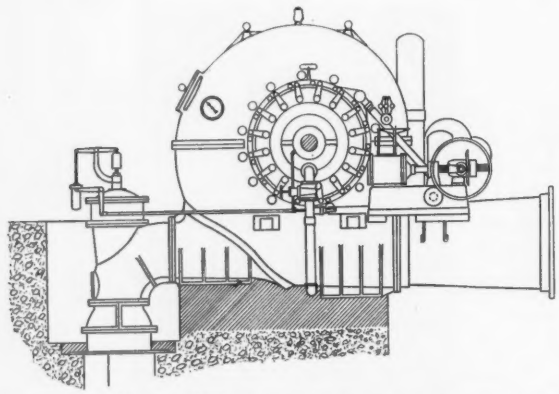


FIG. 3. A 6400-HP., 320-FT. HEAD TURBINE EQUIPPED WITH GOVERNOR OPERATED PRESSURE REGULATOR

Water saving method of control is accomplished with needle nozzles which supply only as much water as needed. If pipe line protection is needed, this can be accomplished with a pressure regulator usually working in conjunction with the needle valve. Figure 4 shows an 1100-ft. head, 6000-hp. impulse water turbine. The water is controlled by a needle nozzle in conjunction with an auxiliary needle nozzle, the needle of which is mechanically connected to the main needle and is so arranged that it opens automatically as soon as the main needle closed rapidly or beyond a certain predetermined point. In this way, the auxiliary nozzle maintains sufficient vent to avoid a dangerous rise of pressure in the pipe line. This auxiliary nozzle is also fitted with an independent slow moving mechanism which gradually closes the nozzle when the main needle stops moving, thus conserving the water supply.

At high head plants only one jet of water is used per wheel, but at lower head plants more than one may be used. At a Western station with a head elevation of 111 ft., vertical impulse wheels are used instead of reaction turbines because the water contains silt which would wear reaction runners, necessitating frequent replacements, while the impulse wheels need only have their buckets replaced. Six nozzles provided with governor actuated deflectors are used for each wheel and the number of nozzles in use can be changed to obtain good efficiencies at different loads.

TURBINE TESTING

AFTER INSTALLATION, turbines are usually tested for efficiency at different gate openings, which consists of measuring the water used and determining the turbine output. With small turbines a prony brake can be used, but generally the horsepower output of the turbine can be calculated from the output of the generator, the generator efficiency being known.

At some plants it will be practical to obtain any load conditions desired for the test, this being particularly true of large systems where the load can be obtained as desired; and even though the system power factor is not near unity, the field excitation of the unit under test can with few exceptions be adjusted to generate at unity in order to secure a more accurate measurement of the generator load. Standard portable testing meters are used along with the switchboard instruments to insure correct results. When the exciter is also driven by the turbine, its load must also be computed with the generator. If the oil pressure governor pump is driven from the main shaft, its power must be known and added to the turbine output, unless it is disconnected or allowed to run idle, as hand control of the turbine gates is preferable anyway, during a test, to assure a steady load. Water rheostats are used to furnish artificial load for turbine generators when load conditions are not satisfactory on the system. For three-phase generators, the rheostat has three vertical pipes spaced triangularly. They are connected to the generator leads and insulated from each other; the load can be regulated by raising and lowering the pipes into the river.

The standard method of measuring water is with a weir, but in the case of a large river this may be impractical because of the expense of construction. The other methods of measuring water are with pitot tubes, current meters or floats, located either in the head or the

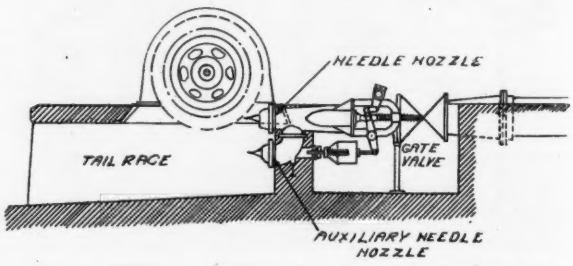


FIG. 4. 6000-HP., 1100-FT. HEAD IMPULSE TURBINE

tail race. In order to measure water with these methods, the channel must be fairly free from rocks. The handling of the floats, meter or pitot tube must be done by somebody who is practiced and also understands the liability of errors and how to avoid them.

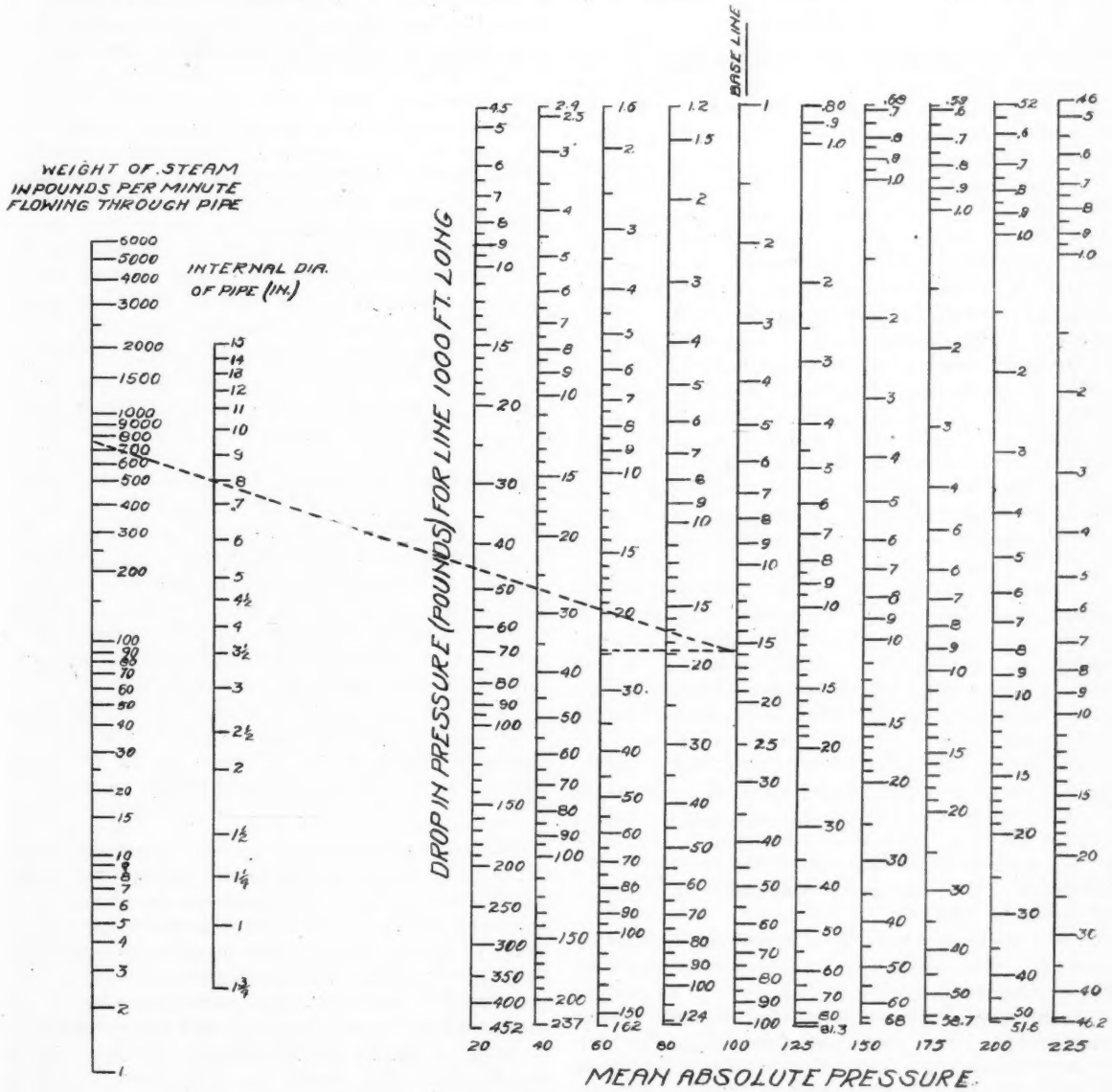
Another method of measuring water is the titration or chemical method. A salt solution of definite concentration is mixed with the water flowing through the turbine where it mixes thoroughly. Samples are then taken from the tail water and the flow of water can be computed by multiplying the rate of flow from the solution tank by the ratio of the concentration in the tank to that in the tail race.

When turbines are tested by any of the foregoing methods, a quantity gage can be installed and calibrated on the turbine and penstock. The quantity of water delivered to the turbine at different outputs can then be obtained at any later time, thus checking the turbine performance.

Chart for Determining Flow of Steam in Pipes

By Ernest Owen

THE accompanying chart shows the relations existing between the various factors determining the flow of steam pipes and will be found useful in calculating pressure drops. The scales are logarithmic and all values may be read directly.


WEIGHT OF STEAM IN POUNDS PER MINUTE FLOWING THROUGH PIPE
INTERNAL DIA. OF PIPE (IN.)
BASE LINE
DROP IN PRESSURE (POUNDS) FOR LINE 1000 FT. LONG
MEAN ABSOLUTE PRESSURE
20 40 60 80 100 125 150 175 200 225

$$p = \frac{w^2\left(1+\frac{3.6}{d}\right)L}{87^2 D d^5}$$

p = DIFFERENCE IN PRESSURE BETWEEN THE TWO ENDS OF THE PIPE IN POUNDS PER SQ. IN.
w = WEIGHT OF STEAM PASSING IN POUNDS PER MINUTE
D = DENSITY OF STEAM OR WEIGHT PER CU. FT.
d = INTERNAL DIAMETER OF PIPE IN INCHES
L = LENGTH OF PIPE IN FEET

CHART SHOWING FLOW OF STEAM IN PIPES

To use the chart, proceed as follows: Lay a straightedge across the given pipe diameter and the value showing the weight of steam in pounds per minute flowing through the pipe. Extend the straightedge to the right and note the point where it intersects with the base line. This line, as well be seen, serves the double purpose of acting as a base line and also indicates the drop in pressure for a mean absolute pressure of 100 lb. per sq. in. For any other absolute mean pressure, 60 lb. per instance, draw a horizontal line from the point of intersection of the straightedge with the base line to the mean pressure line desired.

Thus, in the example illustrated it was desired to find the drop in pressure in 1000 ft. of 8-in. pipe for 760 lb. of steam flowing per minute for a mean absolute

pressure of 60 lb. The result of the operation gives us a drop in pressure of 24.5 lb. per 1000 ft. Had the mean absolute pressure been 100 lb., the drop in pressure would have been shown on the base line, as being 15.9 lb. per 1000 ft.

This result may be checked by the use of the formula given in the chart.

The Care of Boiler Settings

By W. M. McNeill

IN MOST power plants the boiler settings receive about as little attention as anything around the power house, except, possibly, the firemen. The result is that before it is realized by those in charge that anything is wrong with the setting, an arch or a lining is ready to fall down, a side wall is bulged out or a baffle has broken down and the boiler must be cut out of service for repairs. In most plants there are regular intervals at which boilers are out of service for cleaning and internal inspection. If, at such times, a thorough inspection of walls, linings, arches, bridgewalls and baffles is made and all defects repaired, it will save considerable time, annoyance and expense.

In making an inspection of the walls, it should be noted whether or not they show any signs of bulging out at the sides. Especially is this true, if the brick work carries either part or all of the weight of the boiler as is the case with some types of boilers. Where the boilers are supported by an independent iron or steel structure set into the brick work, care should be taken that the brick does not form large holes or cracks, leading from the furnace to the supporting structure through which the furnace gases may reach them, or the supporting structure is sure to be damaged by overheating. In one plant, in the case of a 500-hp. Stirling boiler, the supporting structure was damaged in this way to the extent that the boiler had to be dismantled, the framework straightened up and the boiler reset.

A thorough inspection of the lining should not be overlooked. If any part shows signs of weakness, it should be repaired before the boiler is again put into service. All loose brick should be carefully removed, the remaining brick cleaned, the bricks covered with a good grade of fire clay mortar and the brick put back and forced in tight.

If the boiler is served by a stoker and the setting is provided with inspection doors, as is often the case, these should be lined with fire brick or tile to prevent the doors from being warped out of shape, as it is next to impossible to close a warped door so that air will not enter around it. The brick or tile will prolong the life of the door. All inspection doors, except, of course, those in the furnace, should be laid full of fire brick. These should be laid in loosely so that they may be easily removed. They will protect the doors from the intense heat and at the same time help to keep out any air that may tend to enter around the door.

After the wall linings and doors have been thoroughly inspected and repaired, the doors should be closed tight and the damper opened wide. By going over the setting now with a lighted candle or torch, any air leaks may be located and repaired. It is a good idea to give the setting a good coating of a good plastic cement at least once a year, as this will insure an airtight setting, or as near airtight as it is possible to have.

The bridgewall also should be given a casual inspection, for clinkers will adhere to it and bricks will be pulled out of it in prying the clinkers off. These bricks should be replaced.

The baffles should be carefully inspected to locate any holes and cracks that will permit the gases to short-circuit the heating surfaces. Baffles seem to be subject to the habit of forming these holes and cracks, and unless they are inspected and repaired at regular intervals may be the cause of a great deal of fuel waste.

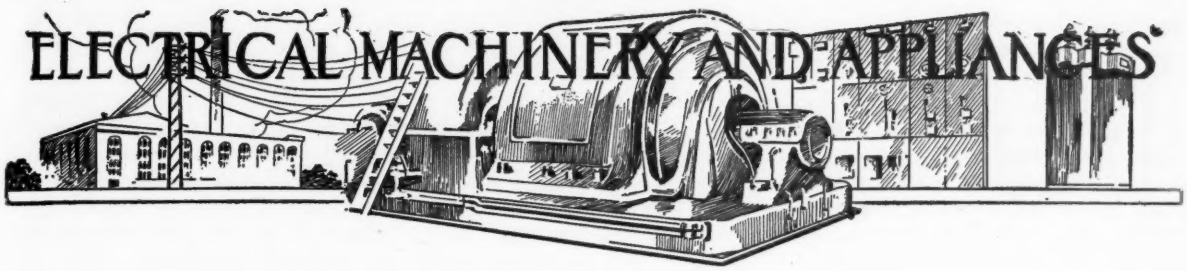
One of the worst enemies of boiler settings is steam and water leaks, which allow water to reach the brick work and especially the arches. In most boiler plants you may find any number of steam and water leaks around flanges, stuffing-boxes and other joints, which allow the water to drip or possibly run in a stream, down on the setting. Water will soften the brick and mortar and cause them to fall out. If water is permitted to reach the setting, it is sure to cause trouble sooner or later. The brick work and the whole setting for that matter should be kept clean and dry.

The arches should also receive attention. In the case of a sprung arch, when it gets into bad shape, there is nothing left to do but to tear it out and rebuild, as it is next to impossible to make any repairs to a sprung arch that will be anything like permanent. With the suspended arch it is different. If a tile or brick becomes damaged, it may be removed and another slid into its place. When the brick or tile of a suspended arch becomes damaged to any extent, it should be replaced at once, otherwise the intense furnace heat will soon damage the supporting iron work. If the tile are kept in good repair, a suspended arch will last indefinitely; but if not, the arch may fail almost any time, due to the supporting iron work being burned down.

With reference to the caution of preventing water from reaching the walls and linings of a setting, this applies doubly to arches. If water reaches the arches, they will soon be damaged beyond repair.

WATER GLASSES have always been a source of danger to the water tenders and firemen of a plant, due to their liability to explosion. The glass tube is, of course, exceedingly friable and even when properly annealed, is liable to fracture at the least expected moments from the slightest nick on its surface, when subjected to boiler pressure. For this reason, water gages should be properly protected to safeguard the good health of the workmen in a plant. A device for this purpose has just come to notice. It consists simply of three pieces of 5/16-in. plate or wire insertion glass which are placed on the two sides and front of the gage. These glasses are held in place by adjustable arms at the top and bottom. The protector is easily removed and replaced with one hand when it is necessary to replace broken gages. This casing prevents bits of glass from flying about the boiler room when a gage lets go.

"HONORABLE mention is the reward given the chap who tries but fails; for one who lacks ambition to struggle no comment is necessary."



Mechanical Features of Motor Installations

MEANS FOR PROPER INSTALLATION; MACHINE DRIVES AND FACTORS REQUIRING CONSIDERATION. BY GORDON FOX

IN SELECTING a motor for a given service, the location and method of drive should receive consideration.

It is desirable to locate motors in cool, clean, light, high and dry places as far as possible. If the motor must necessarily be in a hot place, it must be liberally rated. If it must be in a dirty place, total or partial enclosure should be employed, for dirt causes many a failure. If moisture or fumes are present, the motor should be protected, as far as possible, and the insulation specially treated to meet the condition.

The position of a motor should be such that it is easily accessible for inspection, else neglect is probable. Clearance spaces should be provided for the removal of the entire motor or its parts. In the case of important machines, care should be exercised to see that part replacements may be quickly made. Failing this, the entire motor unit should be exchangeable. It is of advantage to have important motors served by a crane or repair trolley or at least to provide ready means of rigging for handling of motors and parts.

Direct-connected motors are best mounted so as to be intrinsically a part of the driven machine. This is advisable for the sake of retaining alinement but is not always necessary. Usually some form of bracket or platform is arranged. If it is not possible to attach this to finished surfaces, it may be bolted to the frame of the machine. The motor may be alined and the bracket forced into position with wedges. A dam is then placed around the feet of the bracket and any spaces filled with lead.

Motors should not be supported or directly attached to machines which vibrate or shake, as the motors will likely develop trouble under such conditions. Railway, mine and mill-type motors are better adapted than general utility motors to withstand such conditions. In attaching a motor to a bedplate or similar support, through bolts are preferable to cap screws or stud bolts, as the motor may be more readily removed and breakage of a bolt is a less serious matter.

Care should be exercised to have the motor shaft level, otherwise end pounding may result.

When mounting motors upon a floor, it is best to use a base and to keep the motor above the dirt and moisture with sufficient space for sweeping. A base is better than rails, especially where the floor is uneven, due to the tendency for rails to settle away from a plane surface. Motor bases should be heavy enough to retain shape under stress, but they should not be bolted down in a manner to distort them. Large motors may be neatly installed by providing a concrete foundation and anchor bolts, the motor base being alined with wedges and grouted in. Motors without bases should not be grouted in as removal for exchange or repair is too difficult. If a base is not provided, heavy steel plates or rails may be grouted in the foundation, the anchor bolts passing up through the plates and also through the motor feet.

Motors may be readily arranged for side wall suspension by shifting the bearing brackets through 90 deg. They are sometimes attached to the ceiling for driving to the floor above. As the motor usually has a small pulley, it should be borne in mind that the weight of the

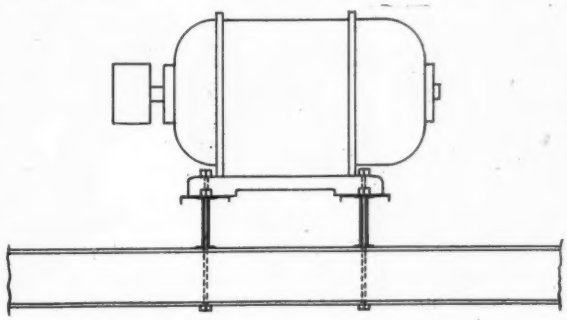


FIG. 1. MOTOR MOUNTED ON CHANNEL IRONS PLACED BACK TO BACK WITH BOLT SPACE BETWEEN

belt decreases the tractive power. It is not the best practice to hang small direct-current motors directly from the ceiling, as they are inaccessible and do not receive proper attention. It is better to suspend the motor on some form of rack.

The structural supports for a motor should be sufficiently heavy and rigid to prevent movement and vibration. Use of channel iron supports for wall or ceiling mounting is suggested as permitting easy alinement and rigidity. Figure 1 suggests some features of such a support.

Many motors are direct-connected to the driven machine, driving through couplings or gearing. Remote drives may be through belt, chain or rope transmission. These various modes of application will be considered in sequence.

COUPLINGS

COUPLINGS of both solid and flexible types are in common use for motor applications. Solid couplings are almost always of the safety flanged type. Flexible coup-

lings supply a considerable measure of protection to the motor. They should be used where there is any possibility for relative movement of motor and machine, where there is vibration or shock in the driven machine and where an end thrust occurs which might be imposed upon the motor.

Although the great majority of flexible coupling installations are successful, this type of coupling is necessarily less simple than the solid flanged coupling and troubles are occasionally experienced. There are many designs of flexible coupling. The leather link and leather laced belt couplings and the rubber buffer coupling are among the older types. As both leather and rubber are subjected to deterioration, all-metal couplings have features of desirability. An all-metal coupling using flexible pins to transmit the torque is shown in Fig. 2. Another all-metal coupling using compression spring is shown in Fig. 3. A successful type of all-metal coupling using laminated discs is shown in Fig. 4. All-metal couplings are particularly well adapted for the more severe service applications, finding extensive use, for instance, in the steel mill.

FIG. 2. PIN-TYPE FLEXIBLE COUPLING

FIG. 3. COMPRESSION SPRING-TYPE FLEXIBLE COUPLING

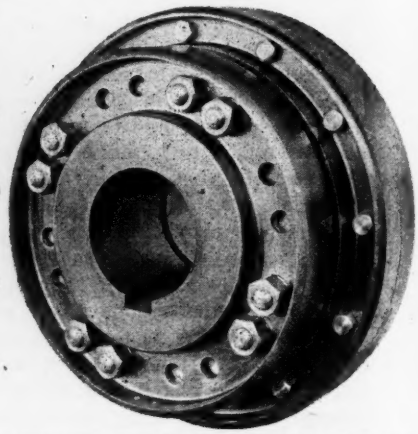


FIG. 4. LAMINATED DISC-TYPE FLEXIBLE COUPLING

Although flexible couplings permit of a small amount of relative motion, they should be alined as perfectly as possible when installed. The margin then safeguards operation in case either part becomes slightly displaced. Limits of misalinement within which successful performance may be expected are about 1/16-in. offset of shaft center lines and 5 deg. angularity between shafts.

Gear Drives

Gear drives permit of compact arrangement, are positive and are particularly well adapted for slow-speed work. They have fair efficiency, ranging from 90 to 98 per cent. They require good alinement, well maintained. They transmit all shocks to the motor. They are usually more or less noisy.

The ratio of the drive gearing depends upon the relation of motor speed under load and desired machine speed. In the case of constant or adjustable speed motors, this ratio is easily determined. In the case of variable speed motors, the proper ratio is not always so readily determined as the motor speed varies with the load. For drives which start and stop frequently, the factors of machine and motor inertia may materially affect the selection of gear ratio for the drive.

The allowable ratio for a single reduction is limited by the allowable diameter and surface speed of the gear and by the minimum number of pinion teeth. For small motors, a 10 to 1 ratio is allowable. For moderate sizes, 8 to 1 is about the maximum permissible. The motor pinion should have at least 15 teeth, if possible, as the teeth of smaller pinions are weakened by their undercut shape. In determining a ratio of gearing, it is well to avoid the maximum possible ratio as this leaves no margin for future change, should such be found desirable. It is better to use an intermediate ratio, but to provide clearances which will permit of a change of the gear ratio in either direction, if desired later. In calculating a gear reduction, the gear should, if possible, have a prime number of teeth so that the shocks due to a repeated cycle of operation may be distributed; the use of an odd tooth prevents the same teeth from meshing so often.

When motors have double extended shafts, placing of the pinion on the commutator end should be avoided if possible, as the shocks and vibration are more severe and the bearing wear likely to be more rapid. Outboard bearings should be used for all geared motors of 100 hp. and larger and, in many cases, for smaller motors. Outboard bearings should be used for ordinary motors of 50 hp. and above when subjected to reversing duty or severe fluctuating loads.

The motor pinion should be located preferably on the same horizontal level and to one side of the driven gear. Bearing wear or slight errors in elevation then have little effect. It is not good practice to locate the motor pinion directly below the driven gear. Bearing wear is then likely to throw excess weight onto the motor bearings. It is also difficult to remove armatures so located. If the arrangement is such that motor elevation affects the meshing of the gearing (also for coupled

drives), it is advisable to have the motor support a trifle low and to supply shims under the motor feet. This arrangement also permits of adjustment to care for differences in individual motors.

Gears are usually of cast iron or cast steel with cut teeth while pinions may be of steel, brass, rawhide, fiber or cloth. The latter types usually have end plates of brass. Steel pinions have excellent life and are not affected by temperature or moisture, but are noisy and cut quickly unless well lubricated. Steel gears are about twice as strong as cast iron. They should be used for important work, where shock or overload may be expected or where the face of a cast-iron gear would exceed 4½ in. The cost of cast-steel gears is about double that of cast-iron gears. The pinion is subject to the more rapid wear, due to its smaller diameter, therefore it is important to have a pinion of good wearing qualities as well as of sufficient strength. Steel pinions are usually forged, of 0.30 to 0.40 per cent carbon steel and are frequently heat treated to increase their strength and durability.

Iron and steel gears ordinarily become noisy at about 800 ft. per minute linear speed but may not be disagreeably noisy below 1200 ft. per minute or even higher. Where it is desired to employ high surface speeds without noise, brass, fiber, rawhide or cloth pinions may be used. Brass pinions, although somewhat quieter, have shorter life than steel. They are particularly adapted to conditions of heat and moisture prohibiting the use of a non-metal pinion, but where noise is objectionable.

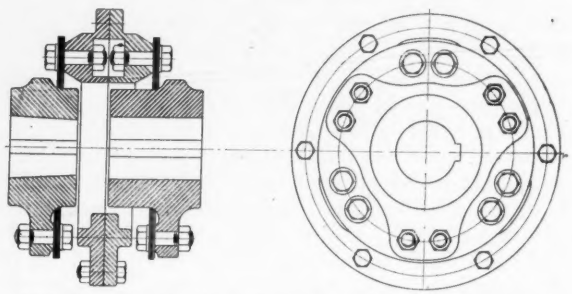


FIG. 4a. DETAILS OF LAMINATED DISC-TYPE FLEXIBLE COUPLING

Fiber pinions are quiet, but are not very rugged and are subject to deterioration by moisture. Rawhide pinions are satisfactory unless subjected to extremes of heat or moisture or excessive load fluctuations or frequent starting, stopping or reversing. For equal strength, the face of rawhide pinions must be about 25 per cent wider than corresponding steel pinions. The surface speed of a rawhide pinion is limited more by rapid wear than by noise. A speed of about 2000 ft. per minute is a fair average limit, but 2500 to 3000 ft. per minute may be used under favorable circumstances of attendance and lubrication, in the absence of moisture and for intermittent service where the life of the pinion is not important. Cloth pinions are quiet, not easily affected by heat or moisture, are quite elastic and give good service when subjected to strains and shocks. The allowable surface speeds correspond to the values for rawhide. Where quiet operation is desired, it should be noted that rigid and massive supports and close fitting bearings, both on motor and driven machine, are conducive to a noiseless drive. The pinion should always be placed as close as possible to the motor bearing.

Figure 5 will be found useful in the selection of gears. Usually the horsepower, speeds and approximate distance between centers are given. With the gear ratio and center line distance given, an approximate pinion diameter may be selected. To use the chart, find the intersection of the horizontal line representing the motor speed with the horsepower diagonal. From this point,

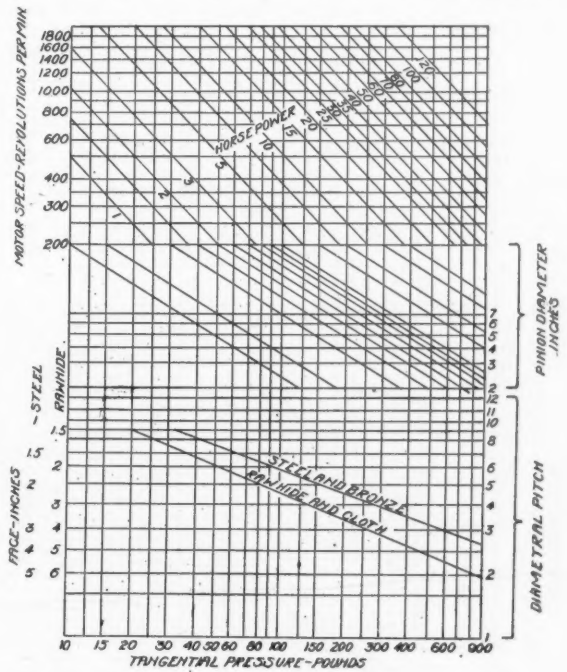


FIG. 5. CHART FOR COMPUTING GEAR DRIVES

follow the vertical of torque to the horizontal representing 1 ft. pinion radius, then follow along the diagonal to the horizontal representing the pinion diameter selected. The vertical at this point represents the tangential pressure at the pitch line. Following this vertical to the curves for steel and rawhide pinions, the approximate diametral pitch and gear face can be determined. The nearest commercial size that will give a good number of teeth should be selected.

Gears must be kept well oiled, and at high speeds some method must be used, the effectiveness of which will not be destroyed by centrifugal force. Rawhide gears should not be oiled, but should be lubricated with talcum and graphite or graphite and lard oil. Gears should always be guarded, both for safety and for protection and to prevent throwing of the lubricant. Inspection openings should be provided in the gear guards at the point of meshing.

Worm gears are used for special cases where a large speed reduction is desired. They are positive, quiet and free from vibration. They have low efficiencies, ranging from 70 to 80 per cent, and require excellent machining and good lubrication. A carefully adjusted end thrust bearing must also be provided. The worm should mesh with the bottom of the gear and should run in oil. If the worm is placed above the gear it will not receive good lubrication. The best rubbing surface speed

for worm gears is about 300 ft. per minute although speeds as high as 700 ft. per minute are sometimes permissible. Worm gears are not reversible; that is, the wheel will not drive the worm. They can sometimes be used in a braking capacity due to this feature.

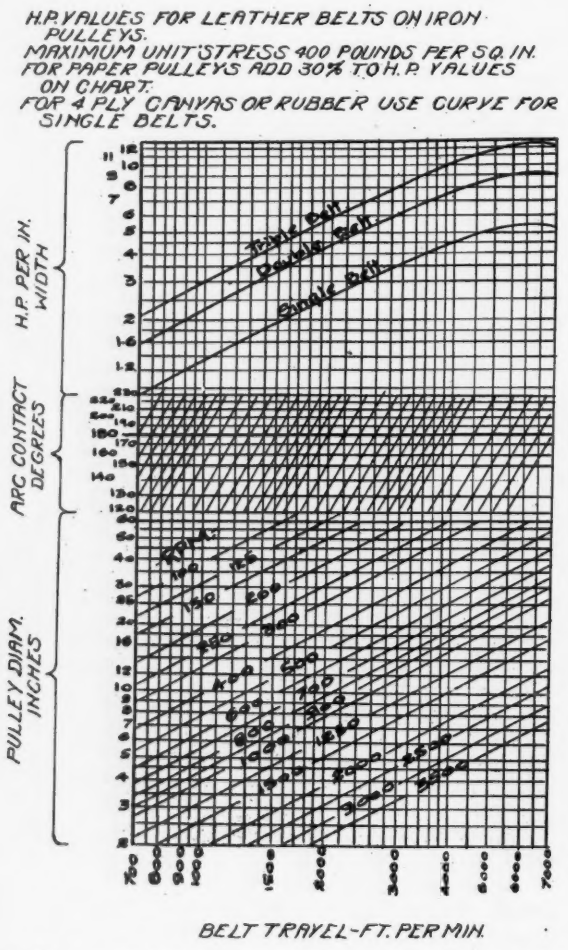

H.P. VALUES FOR LEATHER BELTS ON IRON PULLEYS.
MAXIMUM UNIT STRESS 400 POUNDS PER SQ. IN.
FOR PAPER PULLEYS ADD 30% TO H.P. VALUES ON CHART.
FOR 4 PLY CANVAS OR RUBBER USE CURVE FOR SINGLE BELTS.
H.P. PER IN. WIDTH
ARC CONTACT DEGREES
PULLEY DIAM. INCHES
Triple Belt
Double Belt
Single Belt
BELT TRAVEL-FT. PER MIN.

FIG. 6. CHART FOR DETERMINATION OF PULLEY AND BELT DATA

Friction drives are useful where power is to be transmitted at high speed and low torque, for small amounts of power and where it is desired to change the speed or throw into and out of gear while in motion.

Belt Drives

Belt drives are simple, flexible, inexpensive and elastic, affording protection to the motor in case of overloads and shocks. The drive occupies considerable space, however, is not so positive, has relatively high maintenance cost and is not suited to rapid reversals or other than fairly uniform speed service.

In determining pulley sizes for a belt drive, the desired ratio and the belt speed are determining factors. The power which can be transmitted by a belt varies with the speed, increasing nearly in direct proportion until a linear speed of about 4500 ft. per minute is reached. Beyond this, on account of increased centrifugal stresses, the effective transmitting power is reduced. Belt speeds between 2000 and 4000 ft. per minute are conservative values. Ordinarily about 1000 ft. per minute is the minimum and 5000 ft. per minute the maximum. It is most economical to operate belts within the range of conservative speeds, due to lower first cost and maintenance and minimum power loss. Where very low speeds are used, wide belts are required. The center of the belt then overhangs the motor bearing some distance and trouble may ensue. Decrease of contact surface means higher belt stresses due to greater tension required to prevent slipping. Wherever possible, the lower side of the belt should be made the driving side so that the sag may be at the top.

The chart, Fig. 6, will be found useful for determining pulley and belt data. Consider that the speed of the driven machine and its pulley size are known. Find the intersection of the horizontal line representing pulley diameter and the diagonal representing speed. The vertical at this point represents belt travel. Follow this line to the diagonal of motor speed and the intersection will be on the horizontal giving the motor pulley diameter. Returning to belt travel, ordinarily follow this to the horizontal line representing 180 deg. arc of contact on the smaller pulley, then proceed along the diagonal to the horizontal representing the actual arc for the case in question, which can be readily approximated. Now follow the corrected vertical to the curve for the type of smaller pulley used. The horizontal line at this point will show the horsepower per inch width of belt desirable. From this the values of belt width and pulley face may be determined.

Single leather belts should, in general, be used for widths up to 6 in. and for use over pulleys less than 10 in. in diameter. Double leather belts should be used for most other installations except the very large, when triple belts may be used. Rubber belts are elastic, durable even under adverse conditions of temperature and moisture, have good tensile strength and are uniform in width and thickness; their tendency to stretch, however, is often a disadvantage. Laced belts should not be used for motor drives; endless belts are preferable. Belts should run with and not against the lap at the joint and the joints should be smooth to prevent jarring. The grain side of the belt should run next to the pulley because it is smoother and adheres more snugly, also because the flesh side is stronger and less liable to crack. A belt will transmit about 25 per cent more power without slipping with the grain side next to the pulley.

Wobbling of belts is sometimes due to pulleys having unlike crowns. Flapping is usually caused by slippage between some portion of the belt and pulleys, resulting from grease spots on the belt. A back and forth movement of the belt at the pulley is caused by the edges of the belt being of unequal arrangement.

The distance between centers of the motor and driven shafts depends upon the relative elevation of the smaller pulley and whether the belt pulls on top or bottom. The distance should be such as to allow a gentle sag. Five times the diameter of the larger pulley is usually a safe distance provided the difference between the sizes of pulleys is not too great.

The maximum advisable ratios of reduction through a single set of pulleys are: 8 to 1 for motors about 5 hp.; 6 to 1 for about 10 hp.; 5 to 1 for 20 hp., and 4 to 1 for about 50 hp. If it is desired to ascertain the smallest pulley under which the motor bearings will give service,

this may be done by figuring the total belt tension required, according to the formulas given below.

For iron pulleys,

$$\text{tension} = \frac{3 \times \text{hp.} \times 33{,}000}{\text{belt travel, ft. per min.}}$$

For wood pulleys,

$$\text{tension} = \frac{2 \times \text{hp.} \times 33{,}000}{\text{belt travel, ft. per min.}}$$

Knowing the tension at the center of the pulley, the distances between bearings and the overhang of the pulley center, the shaft may be considered as a simple lever and the thrust on the bearing next to the pulley determined. The thrust per unit of projected bearing area may then be figured if the bearing dimensions are known. For motors under 50 hp. the pressure per square inch bearing area should not exceed 70 lb. For large motors, pressures up to 100 lb. are allowable under favorable circumstances. Since belt tension must increase rapidly with a decrease in diameter, the limitations imposed by the bearings are usually the factors determining minimum diameter and maximum face.

Motor manufacturers have developed a schedule of so-called "standard" pulley sizes which conform with good practice and which may well be used where they may be applied. The table lists these standard pulleys, and also shows minimum allowable diameter and corresponding face recommended. For belts up to 12 in., the pulley face should be 1 in. wider than the belt. For larger belts, the face should be 2 in. wider than the belt.

Where there is insufficient space between the pulley centers to permit an open belt, or where the ratio of speed reduction desired is too great for open belting, or where a compact drive is desired, a belt tightening device on the motor is warranted. As it affords good arcs of contact, low tensions may be used and there is little or no loss in efficiency. The ability of the belt tightener to decrease slippage and to lower maintenance expense as well as to increase reliability should recommend its use in many cases.

Large pulleys and those running at fairly high speeds should be carefully balanced by placing them on a mandrel and balancing them on ways. It is well to use gib keys for pulleys (also for pinions) to facilitate removal.

Series motors should never be belted as the belt is liable to slip off, relieving the motor of load and permitting it to race.

Chain Drive

The silent chain drive is excellent for many applications. It is quiet and efficient and permits of compact layouts. Moreover, it can be used for wide reduction ratios, particularly where the motor cannot be placed close enough for gearing. It is a positive drive and does not afford protection to the motor through slippage, although the effect of shock and vibration may be alleviated. Its first cost is high and the expense of maintenance is usually greater than that of belts.

The center line distances for silent chain drives should be approximately equal to one-half the combined sprocket diameters plus half the diameter of the larger sprocket. In a vertical drive, the small wheel should not, if possible, be the upper one. Where feasible it is best to have the pull on the bottom of the chain. To provide for elongation, particularly in vertical drives, where the chain tends to fall away from the lower sprocket, a sliding base should be used. The driven wheel should be flanged. Where the load is of a pulsating character, it is well to use a driven sprocket with a spring center to absorb fluctuations. Chains and wheels should be protected from dirt. When operating at speeds above 1300 ft. per minute, they throw off their lubricant and therefore should be enclosed and should run in oil. The best practice restricts the chain to not over 1000 ft. per minute travel.

MOTOR MANUFACTURERS' STANDARD PULLEY SIZES

HP Motor	RPM	Standard Diam.	Pulley Face	Minimum Diam.	Pulley Face	Belt Speed Std. Pulley
5	1800	4	4	3-1/2	7	1890
	1100	5	4	4	8	1420
	850	6	5	5	8	1340
7-1/2	1700	5	4-1/2	4	8	2220
	1150	6	5	5	8	1800
	850	7	6	6	8	1560
10	1700	6	5	5	8	2670
	1150	7	6	6	10	2100
	850	8	7	6	10	1780
	600	9	8	7	11	1410
15	1700	7	6	6	10	3100
	1100	8	7	6	10	2300
	825	9	8	7	11	1940
	675	10	9	8	11	1770
20	1700	8	7	6	10	3560
	1100	9	8	7	11	2600
	900	10	9	8	11	2360
	750	11	10	9	12	2160
25	1100	10	9	8	11	2800
	825	11	10	9	13	2370
	600	12	12	10	14	1880
30	1150	11	10	9	12	3330
	725	13	12	10	14	2280
	600	13	12	11	15	2040
40	1150	11	10	9	13	3330
	600	14	12	13	15	2200
50	1100	12	12	10	14	3400
	750	14	12	13	15	2750
	565	16	13	14	16	2360

Ordinary square link chain is used for very slow-speed drives. They are cheap, positive, not affected by moisture and can be used in place of belts under heavy tension. They do not require maintained lubrication. They are rated by numbers as given in the following tabulation:

Chain No.	No. links in 10 ft.	Average ultimate strength in lb.
25	133	700
35	74	1,200
45	74	1,600
55	74	2,200
65	60	2,600
75	46	4,000
85	30	7,600
95	30	8,700
110	25	12,700

The formula for determining the horsepower capacity is as follows:

$$\text{Hp.} = \frac{\text{ultimate strength} \times \text{travel}}{\text{factor of safety} \times 33{,}000}$$

The factors of safety are as follows:

Travel, ft. per minute	200	300	400	500	600	700
Factor of safety	6	8	10	12	16	20

If the load is irregular or subject to shock, use higher factors of safety. The working load depends upon the speed and the character of the work. At increased speeds, the chain is subject to greater shock and requires higher factors of safety.

Voltmeters and Ammeters

THEIR THEORY OF OPERATION AND CONSTRUCTION. PROPER INSTALLATION AND CALIBRATION. BY VICTOR H. TODD

ELECTRICITY is not a physical substance like coal, gas or water which may be measured by cubical dimensions or by weight, but it is an intangible something having neither dimensions, nor appreciable weight insofar as can be definitely determined; consequently electricity cannot be measured by ordinary means, so it must be measured by the effect it produces. There are four well-known effects produced by electricity: (1) Magnetism; (2) chemical decomposition; (3) heat; and (4) static attraction and repulsion; and every electrical instrument utilizes one of these four effects in its principle of operation.

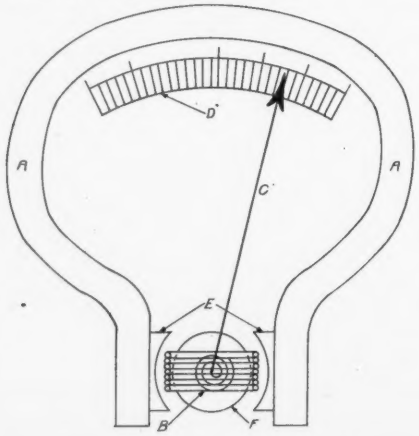


FIG. 1. SCHEMATIC DIAGRAM OF THE D'ARSONVAL TYPE D.C. AMMETER AND VOLTMETER

Every instrument, no matter how delicately constructed, requires some mechanical energy for its operation and it is the function of the electric measuring instrument to convert a definite portion of the electricity being measured into a definite quantity of mechanical energy through the agency of either magnetism, heat or static attraction and repulsion, and the instrument actually measures this amount of ultimate energy, although since this bears a definite relation to the electric current, the instrument is calibrated as measuring a certain amount of electricity.

In every instrument (except chemical meters) there are three main agencies at work: (1) The actively energized agent, (2) the agency against which this first force must react, either actively or passively energized and (3) the controlling or restraining agent. In many instruments there is also a fourth agent called the damping agency which damps out the free oscillations of the moving element and enables the pointer to stop quickly and accurately at its correct indication.

MOVING COIL—PERMANENT MAGNET TYPE

THIS IS one of the earliest principles of operation and even today is unsurpassed in a correctly designed instrument. Instruments operating on this principle may be used only on direct current for the measurement of volts, amperes, micro, milli, or kilovolts and micro, or milliamperes. Referring to the schematic diagram of parts, Fig. 1, there is a small moving coil, B, which is free to turn upon jeweled bearings in the annular air gap produced by the permanent magnet, A, the pole pieces, E and core, F. Attached to the moving coil is a fine pointer, C, which moves over the scale or dial, D. Motion of the moving coil is restrained by two spiral springs which also serve to conduct current to and from the moving coil.

When current is passed through the moving coil, it becomes actively magnetized; this magnetism reacts on the magnetism produced by the permanent magnet in the annular air gap and this results in the production of mechanical energy which turns the moving coil and pointer. This turning or deflection is restrained by the spiral springs which now wind up until their tension is equal to the strength of reaction between the moving coil and permanent magnet, when the pointer comes to rest. Should the current increase or decrease, the reaction will increase or decrease, and the deflection increase or decrease, in every case winding or unwinding the springs until a perfect balance is obtained and the pointer, by indicating on the scale this point of perfect balance, indicates how much current is passing.

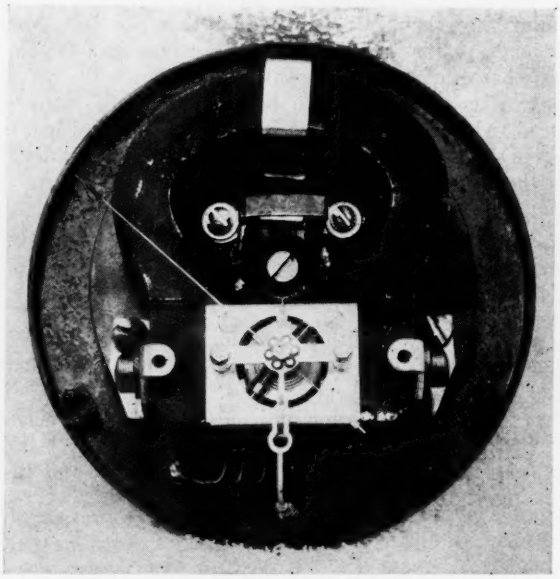


FIG. 2. TYPICAL DOUBLE AIR GAP MAGNETIC SYSTEM

Although the scale may be calibrated to read volts or amperes, it should be perfectly understood that a meter of this type always requires current (amperes) for its operation. In a voltmeter, the element is connected in series with a definite resistance and when connected across a difference of potential (volts) a small current will flow through the resistance and meter and this small current always bears a definite relation

$$I = \frac{e}{R}$$

to the voltage. Since this is the case, the instrument may measure this small current and since it is known that a definite current will be produced by a definite voltage, the deflections on the scale may be calibrated in volts.

In the case of ammeters, the current is generally too large to be passed directly through the moving coil; so, it is passed through a definite resistance called a shunt. By Ohm's law, the passing of a definite current through a definite resistance will produce a definite voltage; or in this case a definite millivoltage, called the "drop" of the shunt. Now, if this definite millivoltage is connected to the moving coil which is in series with a definite resistance, it results in a definite current, and the instrument, by measuring the effect of this current, gives a definite deflection.

Since each step has borne a definite relation to the previous step, the final deflection may be marked to indicate the value of the main current.

Practical illustrations of this may be more instructive.

Let us assume the meter gives a certain deflection on 0.01 amp. Now if we connect the element in series with 12,000 ohms, and place it across 120 v., then from Ohm's law

$$I = \frac{e}{R}$$

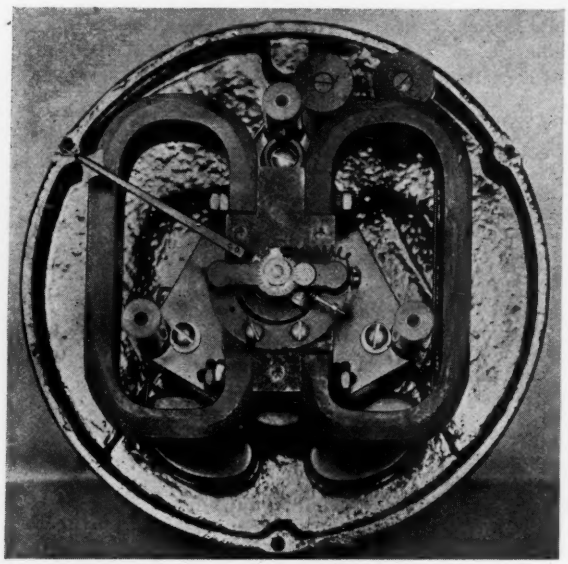


FIG. 3. TYPICAL SINGLE AIR GAP MAGNETIC SYSTEM

we find that 120 v. will produce 0.01 amp. and the deflection of the pointer produced by 0.01 amp. may be marked 120 v.

In the ammeter, let us pass 20 amp. through a definite resistance (a shunt) of 0.0025 ohms; then from Ohm's law the drop will be, $E = IR$ or $20 \times 0.0025 = 0.05$ v. Now connect a definite resistance in series with the moving element until both element and resistor measure 5 ohms, and connect across this 0.05 v. (50 millivolts). From Ohm's law, the resulting current is

$$I = \frac{e}{R}$$

or $0.05 \div 5 = 0.01$ amp. The deflection produced by 0.01 amp. may now be marked 20 amp., as it is definitely known that when 20 amp. passes through the shunt there will be 0.01 amp. passing through the meter.

Damping

In order that the pointer may indicate the point of exact balance, there must be absolutely a minimum of friction between the moving element and its bearings, so the element is provided with sharply pointed steel pivots which rest in polished sapphire bearings in a good instrument. This construction alone would result in such a free movement of the moving element that

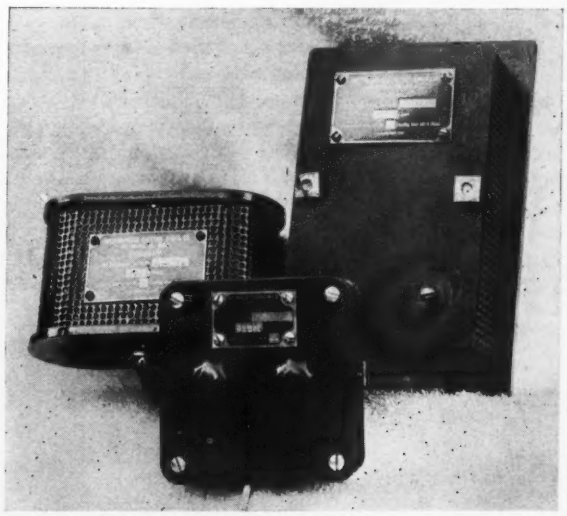


FIG. 4. TYPICAL EXTERNAL SERIES RESISTORS FOR VOLTMETERS

it would oscillate or swing for a long time over the correct point and make it difficult to locate the true reading. So to damp this out, the wire of the moving element is wound on a copper or aluminum frame or bobbin which is moving in the intense magnetic field of the annular air gap, generates small currents in the bobbin, which quickly absorb the kinetic energy of the moving coil and bring it quickly to rest at its correct indication.

Various Designs

There has been almost an unlimited arrangement of the three elements of moving coil, air gap and springs, each design claiming certain advantages. Figures 2 and 3 show two typical arrangements which have proven highly successful in every respect.

In every case, the designers strive for the following points, (1) high ratio of torque (turning effort) to friction (weight of moving element), (2) low current and voltage or energy consumption, (3) permanence of calibration, which includes the elimination of such errors as self-heating and ambient temperature coefficient, change in spring strength, change in permanent magnetism, change in resistance and mechanical changes; (4) minimum price of parts consistent with good performance, and (5) ease of assembly and replacement of parts due to burning out or other damage.

Special Applications

The principle of moving coil and permanent magnet has also been applied to various other measurements such as resistance, temperature, watts, etc., and many combinations, in which this instrument forms the main feature; but it will always be found that where the measured quantity produces a deflection, the current in the moving coil always bears a definite relation to the quantity being measured. For instance, in an instrument used for measuring ohms, the resistance to be measured is connected across a definite voltage usually determined by a separate meter and consquently a current will flow through the resistance, and moving coil which is directly

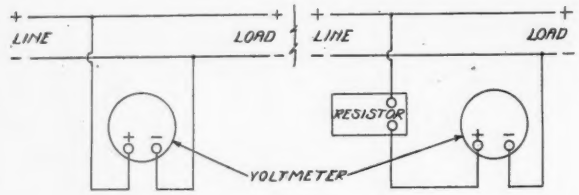


FIG. 5

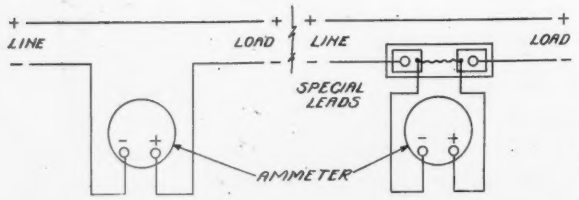


FIG. 6

FIG. 5. PROPER WAY TO CONNECT A VOLTMETER WITH AND WITHOUT A SERIES RESISTOR

FIG. 6. PROPER WAY TO CONNECT AN AMMETER WITH INTERNAL AND EXTERNAL SHUNTS

proportional to the voltage and inversely proportional to the resistance; since the voltage is constant the resulting current bears a definite relation to the resistance and the deflections may be marked directly in "ohms" resistance.

Packing and Shipping

The success of a delicate and accurate electric instrument depends in no small measure on its ability to withstand the shocks of transportation. Reliable manufacturers usually pack their instruments in tissue paper, wrapping paper and corrugated cardboard and then this package is packed in a wooden box sufficiently large to allow several inches of excelsior all around it. When instruments are ordered, care should be taken to instruct the receiving department to handle the instruments carefully when received, as many times much damage is done between the time of unpacking and final installation. In one case, the writer observed a workman unpack a carefully packed instrument. After removing all the wrappings, the workman remarked, "Gee, that was packed good," and threw it on a table several feet away, damaging the pivots beyond repair.

Installing

Upon delivery, many firms require that all instruments be checked before mounting or installing. This, however, is questionable, as with present day instruments but little trouble may be expected and since every instrument should be checked after installation it becomes a small matter to adjust, or remove for repair, the rare instrument which might prove defective after installation.

In selecting a location for a set of instruments, care must be taken that the support is free from moisture, fumes, dust, and excessive vibration. Unless an instrument is provided with special gaskets, etc., to make it watertight such as is demanded by the U. S. Navy for shipboard use, moisture may enter the meter and rust the pivots, thus rendering it not only inaccurate but oftentimes inoperative. The same applies to fumes as for instance in a chemical factory, or to dust, as in a cement or flour mill. Vibration is also to be avoided as the constant hammering on the pivots of the moving element may blunt them in time, introducing friction and consequent inaccuracies in the indication.

Connecting Up

Every electrical instrument, supplied by a reliable manufacturer, will be accompanied by a diagram of connections and this diagram should be followed implicitly in connecting up. Voltmeters should always be connected across or in parallel with the line or apparatus to be measured. In the large sizes of instruments it will generally be found that the series resistance will be self contained, i. e., placed inside the meter case, for all voltages up to about 750 v. With the intermediate size (about 4 or 5 in. in diameter) the instrument will be self-contained up to about 300 v. but above this voltage

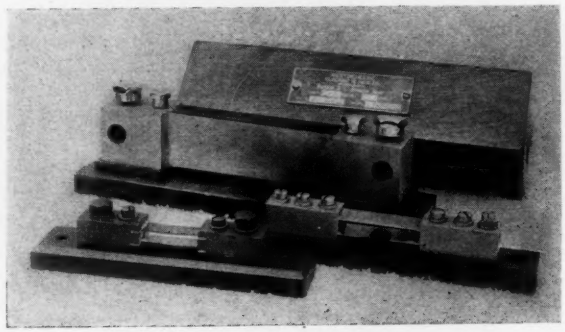


FIG. 7. TYPICAL SHUNTS

an external resistor will be supplied. Care must be taken to connect this resistor in series with the meter. On the small sizes (about 2 or 3 in. in diameter), external resistors are usually supplied above 50 v. Figure 4 shows several typical external resistors, while Fig. 5 shows the proper way to connect a voltmeter both with and without a resistor.

Ammeters should never be connected across the line but should always be connected in series with the load. There is no fast rule regarding the use of external shunts with ammeters and care must be taken to ascertain whether a given make requires a shunt or not. Some manufacturers supply ammeters with internal shunts up to 75 amp., but if desired can furnish millivoltmeters and shunts for any capacity in amperes from a fraction of an ampere up to many thousands.

If an external shunt is supplied, it will also be found that special leads are also supplied and these special

leads must be used to connect the meter to the shunt. They should never be cut or spliced; if too long, fold up the excess and if too short new ones should be ordered or the meter recalibrated. Figure 6 shows the correct way to connect an ammeter in a circuit both with an external and internal shunt; Fig. 7 shows several typical shunts supplied with ammeters.

Testing D.C. Meters

The testing of d.c. voltmeters is accomplished by connecting a portable standard voltmeter in parallel with it and varying the voltage to the desired amounts.

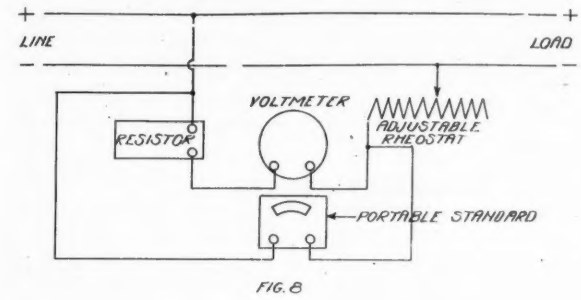


FIG. 8

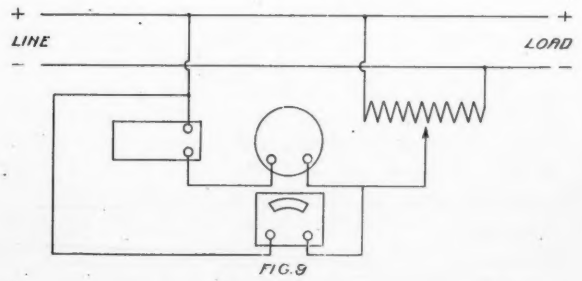


FIG. 9

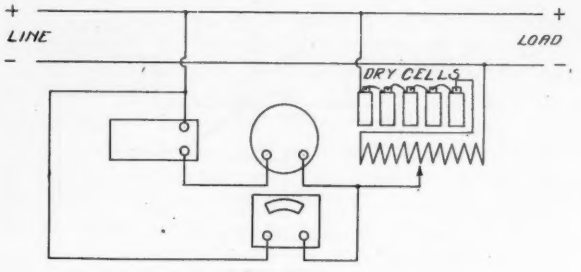


FIG. 10

FIG. 8. CHECKING VOLTMETER BY ADJUSTABLE SERIES RESISTOR

FIG. 9. METHOD OF OBTAINING FROM 0 TO FULL VOLTAGE WITH ADJUSTABLE RESISTOR

FIG. 10. METHOD OF INCREASING SCALE DEFLECTION WITH DRY CELLS

If the meter has an external resistor in series, care must be taken to connect the portable standard to the outside terminals of the meter and resistor and never to any point between the meter and resistor.

The voltage may be varied by use of the field rheostat if available or by inserting an adjustable resistor as shown in Fig. 8. This requires an excessive amount of resistance to get the low readings and the scheme shown in Fig. 9 may be used provided the capacity of the resistance is sufficient not to cause overheating when connected directly across the line. If a check is desired on the higher readings, a number of ordinary dry cells may be connected in series with the resistor to raise the voltage, each dry cell raising the voltage about 1½ v. This connection is shown in Fig. 10. A portable standard voltmeter extensively used in testing and recalibrating is shown in Fig. 11.

Ammeters must be tested by placing in series with a standard shunt and millivoltmeter, and varying the load to get the desired readings. Up to a few hundred amperes, a carbon rheostat forms a good method of controlling the readings. Full load is placed on the meters and the carbon rheostat is connected in parallel with the two meters as shown in Fig. 12. Compressing the rheostat causes more current to be shunted through the rheostat and thus lowers the reading.

If available, the load may be varied by immersing large plates or coils of wire in running or acidulated water and varying the load by either varying the immersion of the plates or the acidity or salinity of the water. In other cases large storage batteries are used and the current controlled through rheostats as shown in Fig. 13. Care must be taken if the line is broken, that the main switch is open or current may flow through this path and give inaccurate readings.

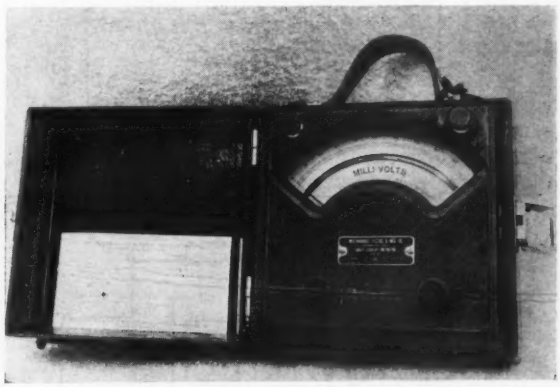


FIG. 11. TYPICAL PORTABLE STANDARD METER

Many times it is impractical to break a circuit to insert an ammeter and in such cases the scheme shown in Fig. 14 may be used to advantage. The ammeter is connected to both sides of a fuse block and then the fuse removed, thus cutting the meter into the circuit without interrupting the circuit.

Checking of heavy current shunts is at best an expensive and laborious proposition and many firms content themselves with a periodic check on the meters alone. This is quite safe as it is rare to find a large shunt change even a fraction of a per cent from its original adjustment. In checking the meter alone, the most convenient apparatus is a 6-v. storage battery of 40 or 60 amp.-hr. capacity, a small carbon rheostat and a 5-amp, shunt and standard millivoltmeter. The connections are made as in Fig. 15, and the meter checked to see that it gives the correct indication as called for on the dial. All meters should be marked somewhat as follows: "50 millivolts at shunt terminals equals 6000 amp. on dial," the figures, of course, depending on individual cases.

Changing Capacities

Many times it will be found necessary to change meters to another capacity. Voltmeters may be changed simply by adding or removing series resistors. Voltmeters are usually figured in "ohms per volt." For instance if a 150-v. meter has a resistance of 7500 ohms, it is said to have a sensibility of "50 ohms per volt." (i.e. 7500 $\div 150 = 50$). Now if it is desired to change to a new capacity simply multiply the voltage by 50 to get the required resistance. For instance, for 50-v. service this meter would require 50×50, or 2500 ohms; or for 300-v. service it would require 50×300, or 15,000 ohms.

In changing ammeters it is generally necessary to get a new shunt of the same drop. For instance, if the meter is used with a 100-amp., 50-millivolt shunt and it is desired to double the capacity, it is simply necessary to buy a new shunt with a capacity of 200 amp. and 50 millivolts, and use a constant of 2 for the meter scale or change the scale figures. It will thus be seen that the same ammeter may be used to record a load of from a few amperes to many thousands simply by providing a shunt which gives the correct millivolt drop at its rated current.

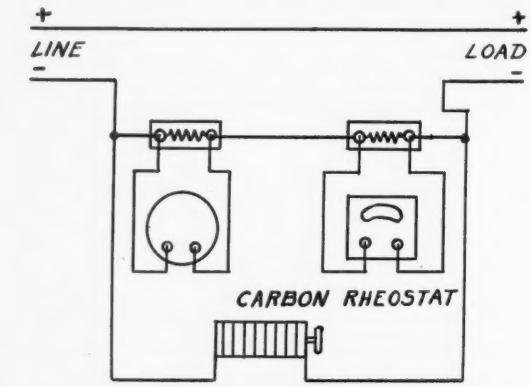


FIG. 12.

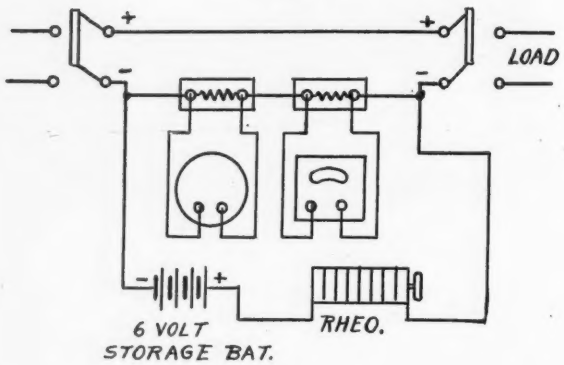


FIG. 13.

FIG. 12. USING CARBON RHEOSTAT TO LOWER THE READING
FIG. 13. SUPPLYING LOAD WITH STORAGE BATTERY

According to an estimate by Eugene Stebinger of the U. S. Geological Survey, the total oil resources of the world amount to 43 billions of barrels. Of this total, the United States has about seven billion barrels.

Electrically Operated Auxiliaries on Board Ship

By William H. Easton*

IT IS a curious fact that, though nobody would today dream of using steam engines to operate a number of small machines scattered throughout a hotel, a warehouse, or a factory, precisely that is being done on practically all American merchant steamships. On land, the electric motor is used for every possible power purpose, from the 1/20-hp. sewing machine to the 20,000-hp. rolling mill, because of its convenience of installation, efficiency of operation, ease of control, safety, quietness, cleanliness and absence of heat and moisture; but on sea, the steam engine is still the standard drive for winch, capstan, windlass, steering gear, pump, fan and refrigerating machine.

A study of the situation shows that this adherence to what can truly be termed an obsolete form of drive is due almost entirely to the conservatism of marine men. This conservatism is entirely natural and proper, for no rule has a higher justification than the universally accepted dictum that "no machine must be placed on a ship until its utility and its reliability have been proved beyond question." But the time has come when the

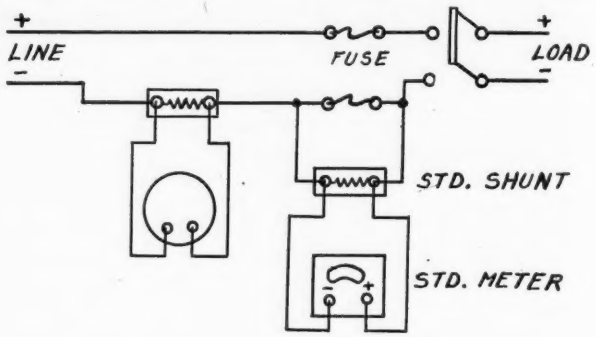


FIG. 14.

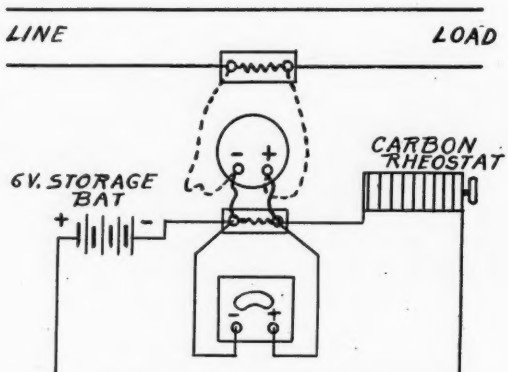


FIG. 15.

FIG. 14. INSERTING STANDARD BY REMOVING FUSE
FIG. 15. CHECKING AN AMMETER AS A MILLI-VOLTMETER

*Engineer with the Westinghouse Electric & Mfg. Co.

veteran donkey engine must yield to the electric motor; for the greater utility of the electric motor as compared to the steam engine, is proved by hundreds of thousands of land installations, while its reliability on shipboard is shown by its record of many years of service on naval vessels, motor ships and other types of vessels.

Consider for a moment the thousands of feet of steam and exhaust piping that run through a ship with steam-driven auxiliaries. These pipes are awkward and expensive to install and much in the way wherever they run. They are apt to leak, liable to break, sometimes freeze up in cold weather, and often cause undesirably high temperatures in holds and living quarters. Furthermore, because of the waste of steam in the pipes due to condensation and leakage and the poor economy of the small engine, the entire system is woefully inefficient, which is a matter of considerable importance in these days of high fuel costs.

But when motor drive is used, all of these disadvantages are eliminated. The cables that carry the current can be easily laid, occupy no valuable space, and when properly installed, cannot be damaged in ordinary service. The motors are quite as reliable as the engines; they are automatically protected against overloads; they can be made absolutely waterproof; and if an accident should occur, all parts are light, easily accessible, and can be readily repaired on board ship. The fuel consumption of the ship is reduced because the motors operate with high efficiency; the transmission losses are small and there are no stand-by losses whatever. Nor does the use of motors involve any special change in the ship's organization, for she is already equipped with an electric system, which merely needs enlarging, and she almost always carries a competent electrician.

Consequently motors will in almost all cases prove more economical than steam engines, but there is a still more important reason for their use—and one that must especially interest the progressive American shipping man—and that is, that the introduction of electricity for power purposes on shipboard will unquestionably in time greatly increase the all-around operating efficiency of the ship.

Ten years ago, this last statement would not have been justified for it must be frankly admitted that the motor-driven winch of today (in which the motor merely takes the place of the steam engine) is only slightly superior to the steam-driven winch because of its somewhat easier control and rather greater agility.

But to believe that the present electric winch represents the last possible word on the subject is to ignore the history of electrical development in every branch of human activity to which it has been applied.

Take illumination, for example. At first, the sole purpose of the electric lamp was to take the place of the gas jet or the oil lamp, and no one suspected it could do more. Indeed, there is a story to the effect that a prominent electrical official resigned and went into another business in 1888 because he felt that there was no further future in electric lighting. But as we all know, electricity began where the other illuminants left off; and today we have a science and an art of illumination undreamed of 30 yr. ago.

In the same way, the electric motor took the place of the horse on the street car and gave us the subway; it took the place of the main steam engine in the factory, and developed into a thousand highly specialized drives that are responsible for astonishing increases in production; it began as the simple telegraph and has given us the miraculous wireless; it entered the home in the shape of a flatiron and it is now revolutionizing housekeeping.

Electricity can therefore be relied upon to solve problems that are far beyond the reach of other powers; and that it has ample opportunity to increase the all-around efficiency of a ship is evident from the following considerations.

The earning capacity of a cargo vessel depends upon the time required between cargoes. This time can be decreased (and the ship's earning power increased) by reducing either the time at sea or the time at port. The first can be accomplished by increasing the speed of the ship, but as pointed out recently by an eminent ship operator, a speed of from 10 to 12 knots must be considered the average maximum for a long time to come because of the large amount of fuel needed to increase this speed. But to reduce the time in port is an advantage in every respect so that the attention of the shipping world must be directed here. Of course, the value of more ample docking facilities and more efficient cargo-handling apparatus in our major ports is obvious; but since a ship may spend much of her time at ports with crude facilities or none at all, the more rapidly she can handle cargo with her own equipment, the better investment she is going to be.

Steam-driven auxiliaries have obviously about reached the limit of their development. Electricity must therefore step in, and though what it will accomplish cannot be foretold at present, it will in time undeniably revolutionize our present cargo-handling methods.

Scale

By Charles F. Knapp

"What yo' doin' deah, yellow boy?" queried Sam,
As he stared at the sweating coon,
Who was wheeling scale by the barrels full
Out of the boiler room.

"Doin'? Good Lawd man, ah's lab'ring,
Ah's been doin' dis heah all day;
Takes out one load, goes back fo' another—
Dat's de way ah makes mah pay!"

"Yo-all heah dat buzzin' sound,
What's coming from belo'ah?
Dat's dem white trash borin' tubes,
Dey knocks out de scale, galo'ah!"

"An' de chief elects me to dis heah job,
A cleanin' up deah mess;
Dat boiler room seems so full of scale—
Deah ain't no end ah guess!"

"Ah tells de chief ah's goin' tuh quit,
Ef de don't stop buzzin' soon,
Ah sees scale all day an' scale all night—
Doggone dat boiler room!"

Strengthening Machine Parts

WEAK POINTS IN APPARATUS INDICATED BY CONTINUAL BREAKING OF CERTAIN PARTS. SUGGESTIONS FOR STRENGTHENING. BY H. A. JAHNKE

IT IS quite possible for an engineer to make improvements on some of the equipment under his charge, especially where certain parts of an engine, pump, etc., break too frequently and these parts have to be removed often at much expense and delay by having the parts made specially at some machine shop or ordering them from the maker of the apparatus.

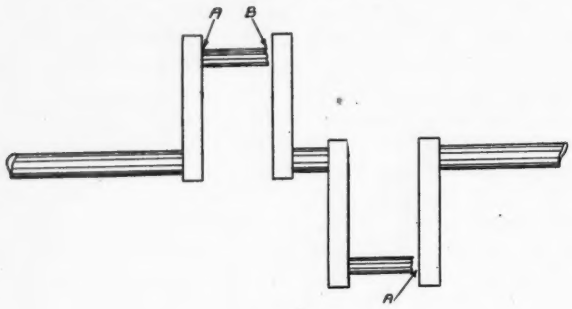


FIG. 1

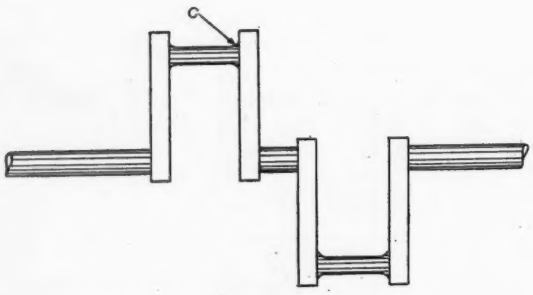


FIG. 2

FIG. 1. SHARP CORNERS CAUSE WEAK POINT IN CRANKSHAFT
FIG. 2. INCREASING STRENGTH OF CRANKSHAFT BY THE USE OF ROUND CORNERS

Should you find that some part of an apparatus in your charge breaks too frequently, not due to some wrong adjustment, examine and study the part to find what causes the break. It may be that this part of the apparatus is too weak for the purpose for which it is designed.

Then if, in your judgment, the part is made too weak, if possible have it made heavier where it is most needed, or make some other change in the equipment to avoid breaking too frequently or write to the maker of the apparatus advising that such part on your equipment breaks too frequently and that in your judgment this part is made too weak and then suggest your idea as to improving the apparatus. The maker will be only too glad to take the matter up with you, as no maker of apparatus approves of any part of an engine, pump, etc., breaking where the fault lies in the design of the apparatus.

CRANKSHAFT BREAKING TOO FREQUENTLY

SOME YEARS ago, the writer had charge of a power plant where a hoisting engine was in use. The crankshaft on this engine would break frequently and it was the practice to carry one extra crankshaft in stock. One day, the shaft broke just as the plant was very busy. After the new shaft was in place and all well again, I made up my mind to find what caused the shaft to break so often. I knew the trouble did not lie in any of the adjustments and that there was a careful man operating the engine, so I was quite sure that the fault lay in the crankshaft pins. Type of crankshaft is shown in Fig. 1 and the crankpins used to break at A. It will be noticed that the corners of the pins and cranks are cut very sharp at A, B. I came to the conclusion that these sharp corners were the cause of the pins breaking, as this would weaken the pins; so the next shaft we ordered, I advised to have the corners rounded off as shown in Fig. 2 at C, also to increase the diameter of the pins ¼ in. I knew this would require no larger crankpin boxes, as the old boxes were of the babbit type and had ample babbit space.

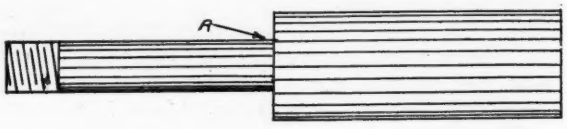


FIG. 3

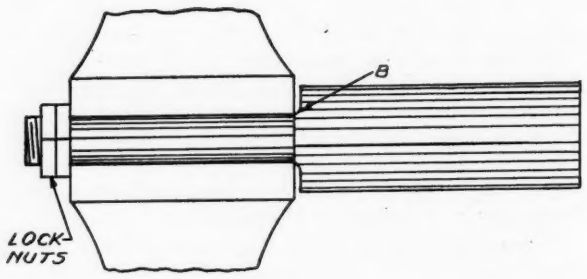


FIG. 4

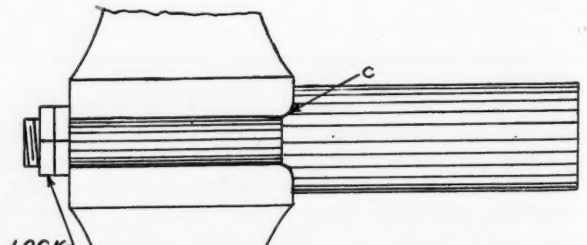


FIG. 5

FIG. 3. PIN WITH SHARP CORNERS
FIG. 4. PIN WITH ROUND CORNERS PREVENTS SHIFTING DEVICE FROM MAKING A SNUG FIT
FIG. 5. ROUNDING CORNERS ON BOTH PIN AND SHIFTING DEVICE ELIMINATES TROUBLE

When one of the crankpins broke again, the new shaft was placed. After this there was no further breaking of the crankpins.

If we take into consideration the expense of a new crankshaft, the delay of the hoisting engine, when replacing the shaft, and loss of production, we can imagine what a loss this was to the concern.

The puzzling part of it was that nobody had thought of trying to find why the shaft broke so often. I suppose they merely considered it an accident and kept on buying new crankshafts.

Machine Part Breaking Too Frequently

In another instance when the writer had charge of a power plant and of all repairs and installations of the machines throughout the plant, one machine in particular in the factory gave much trouble by continually breaking a pin used on the belt shifting device. The pin used to break at A, as shown in Fig. 3, always breaking at the same place. One day, as the pin broke again, I decided to remedy the trouble if possible. I knew I could not enlarge the diameter of the pin without changing other parts of the apparatus. There was but one thing to do; that was to make improvements on the pin some way. So I decided to make the improvement on the pin where it was reduced from the larger diameter to the smaller. It will be noticed that where the pin is reduced, the corners are very sharp. I decided to have these corners rounded off, but in rounding them the pin would not fit sung up against the shoulder of the shifter part into which the pin fits, as shown in Fig. 4 at B. Then I decided to round off the corners on the shifter part as shown in Fig. 5 at C. This made the pin much stronger where it was reduced and there was no further trouble.

No doubt there are many instances where improvements can be made on power plant equipments where bearings, pins, etc., cause much trouble and expense by breaking frequently.

I could mention quite a number of improvements I have made on power plant equipment, but I thought the two mentioned above would give an idea what can be done.

Bonus Systems

Discussing the Relative Advantages and Disadvantages of Various Bonus Systems. By W. A. Darter

A BONUS SYSTEM for employes is a system whereby employes may receive additional earnings besides their regular salaries. This extra earning is given for additional service above a given stated service. A bonus system is based on the fundamental law that every man shall receive a reward according to his labors. The ideal bonus system is that system which serves the employes best and at the same time advances the best interests of the company.

The purpose of a bonus system is to create an interest in the individual employe for producing better results for the company he is serving. It should create a good will between the employes and the employer. It should also promote co-operation and loyalty between the employes and between the employes and the employer. It should stimulate the salesman to sell more goods, the office crew to be more accurate, and the operator to become more efficient.

It is a conceded fact in the commercial world that a reward for interest and efficient work will always produce a paying return. A good will between an employe and the employer is one of the best assets a company can have; and this good will of the employe can always be secured by a good will toward him and a reasonable salary or bonus for interest and service given.

In all companies, there are always some men who are more efficient than others doing the same class of work. To keep these men on the same salary without giving them an opportunity for earning extra pay will cause them gradually to set their pace to conform with the average man. The correct bonus system will develop this individual interest and pay in the end much more than its cost.

A bonus system created on wrong principles may do harm as well as good. Its results must not be rivalry between the men to the extent that they do not pull together. Rivalry among the employes will sometimes lead to trickery and plotting that will tend to cause the other fellow to lose out. A bonus system must not have the tendency to cause the employes to keep secret from other employes any efficient method of doing their work. This will naturally keep down the possible average efficiency.

To get the best results from a bonus system, it must be based upon correct principles. The best basis for a bonus system is to pay a minimum salary or wage, the amount of which is based upon what the average man can do, or be hired for. Then all over this that a man can earn becomes a bonus. The ideal salary or wage is the salary or wage that will exactly cover the service given by each individual.

There are two ways of paying an employe. One way is to pay him for so much time given in service; the other way is to pay him for doing so much work. The employe who is being paid for time in service could receive a bonus only on extra time put in, or on better than average efficiency. The employe who is paid for doing so much work can receive a bonus on more than average work done, or results achieved.

There are several forms of bonus systems; each condition will call for a different system.

One of the simplest bonus systems is the giving to each employe at the end of a period of six months or a year, a certain part or a whole month's pay. With this system, sometimes the number of years of service given by the employe is taken into consideration.

This is practically the same as a straight wage system, except that the value of one month's pay is held back from the employe until this period of time has passed. It is generally given in order to hold the employes in service so that the labor turnover expense will be less. As a whole, it serves the company very little;

except at the time the bonus is given, the men show little extra interest in their work. This system does not bring out the individual interest and fails to give the company the returns it should receive for this outlay of money. It is reasonable to believe that if this bonus were distributed throughout the year to the employe the extra pay would employ a better class of workmen and as a whole the net gain would be a great deal more.

Another simple bonus system is offering a reward to an individual or group of men for doing more work or doing it more efficiently than another individual or group of men.

This system will usually produce rivalry between these men, and will under certain conditions produce good results; it will also cause the men to plot against each other to cause each other's downfall. It will also sometimes result in enmity between the men and the foundation for co-operation is lost. Also, after the best side has been shown, and they always capture the prize, then the weaker side loses interest and the reward ceases to bring results. As an example, in a certain power plant a reward was offered to the engineering shift that showed the least average B.t.u. of heat per kilowatt-hour during a month's run with all operating conditions the same. It developed that when one side realized that they were falling behind the other side, they created a bypath for the fuel oil around the oil meter. As a result, the losing side became more careless because they did not have to try to make a good showing. Enmity was bred between the two shifts and co-operation was lost.

One of the best systems and the system most used is the profit sharing system, which gives every employe a certain per cent of the profits of the company, based on his salary.

Generally these earnings are distributed once a year; and to some extent, as a result, the interest among the employes will not be the same throughout the year. Yet this bonus, when all parts of the company are taking an interest, will have the tendency to keep the men interested, and promote loyalty and good will between the employes and the company. It also happens sometimes, when one department of the company is losing money, that another department of the company will lose interest, even though this part of the company is in a position to make excess profits. Hence, as a whole, the net profits of the company will be less. Also, in profit sharing there is generally no loss sharing, and the company loses during a bad year. If the employe is made to stand part of the loss, then the average employe will fail to see the justice of it and become offended.

Similar to the profit sharing system is a system where each department of the company receives a bonus on extra service above a given minimum service. This system if carried out on the right basis is also a good one. If the bonus is paid at short intervals, it will stimulate the average employe to do better work and more of it.

The best results are obtained when the average salary is not too high, and where the minimum service is not made too high. If the average salary is high and the minimum mark is set high, then the average employe knows he has little chance to reach the point where he will receive extra gain, hence he loses interest and does not exert himself more than is necessary to keep his place in line.

There is a tendency among some employes to slight their work in order to gain a definite point. As an example, a bonus was offered to each meter reader for additional meter readings above a given minimum. As a result the meter readers contested for the thickest settled district and in some cases caused friction between them. It also caused the reader to skip some meters that were hard to reach, and necessarily called for extra time in reading them later. It also caused them to read others inaccurately, due to their haste, and this in return caused the office more work in rereading these meters and settling disputes, and as a final result it cost the company more to straighten out errors than it saved in decreasing meter readers.

A very simple but result-getting bonus system is to pay a certain bonus to each individual for each good suggestion that is turned into the company and used. This method puts every employe to thinking and studying the conditions under which he is working. This system does not call for co-operation among the employes or between the employes and the employer, yet it promotes interest and good will among all.

When an employe makes a suggestion and that suggestion proves to be a good one and is put into operation, the employe will feel more forcibly that he has a part in the operation of the company. This will create more interest and loyalty in the employe, and will make him more efficient.

Any bonus system that will cause the average employe to exert his best efforts for the company's good, and that will develop the individual and promote loyalty and co-operation, without too much cost to the company, will pay good dividends.

Standard Lamp Voltages

DURING the early days of making carbon filament incandescent lamps, it was difficult to get them to a standard resistance suitable for a definite voltage, hence it was desirable that customers have various voltages to be able to use lamps as they ran. The result was some 31 market voltages between 100 and 130. The difficulty remained even with treated carbon, metallized carbon and the early tungsten filaments; but with present drawn tungsten filaments the lamps can be made very exactly for a given voltage, and it is, therefore, desirable to standardize on a few voltages, to reduce cost of lamps and complications in marketing.

Motors and fans will usually operate satisfactorily at any voltage from 105 to 125; but heating devices are made in two ranges, 105-115 and 115-125 volts, hence the logical standards for lamps are 110, 115 and 120 volts, and manufacturers are urging that systems be standardized to these voltages. At present, 78 per cent of systems are so standardized, and the balance can be readily brought in line by testing up at various points at the lamp sockets, and determining which voltage will most nearly meet present conditions. Only slight changes will ordinarily be needed, which will be more than compensated by the greater simplicity of operation.

OF THE eight million motor cars in the world, it is stated that over 7,600,000 are in the United States. These, it has been estimated contain 90 per cent of all internal combustion engines.

Heat Insulating Properties of Cork and Lith Board

CORK BOARD SHOWS A HEAT INSULATING PROPERTY APPROXIMATELY 5 PER CENT GREATER THAN LITH BOARD. BY A. A. PORTER, J. P. COULDERWOOD, A. J. MACK AND L. S. HOBBS

THIS PAPER describes a series of tests made in the Engineering Experiment Station of the Kansas State Agricultural College upon the heat insulating properties of two insulating materials, cork and lith board. For these tests a cubical test box, made of cork board with one side open for the testing of insulating materials, is placed in a refrigerated room. Inside the box is located an electric heating coil which supplies a measured amount of heat at a uniform temperature. Temperatures both internal and external are measured by means of thermocouples.

Internal test box dimensions are 2 ft. by 2 ft. by 2 ft. and the walls are 3 in. thick. Three coils are arranged in the center of this box so that they may be connected in series, making it possible to vary the intensity of the heat supplied. A 220-v. d.c. circuit supplies the energy for these coils through an external resistance. A 32-v. storage battery is floated on the line to maintain a uniform voltage. A millivolt-meter used in connection with multiplier, a shunt and a two-way mercury switch is made to measure both the impressed voltage and the amperage supplied to the coils.

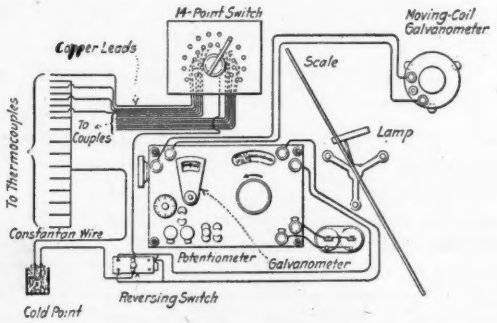


FIG. 1. WIRING DIAGRAM OF TEMPERATURE MEASURING EQUIPMENT

Temperature measurements were made with copper-constantin thermocouples, located at points as indicated on Fig. 2. The thermocouple voltage was measured by balancing it with a standard E. M. F. The wiring diagram is illustrated in Fig. 1. The potentiometer was connected with an external galvanometer to make it possible to secure readings of greater accuracy. The thermocouples were calibrated, their cold ends in an ice bath, with a standard thermometer. The refrigerator insulated with cork board was cooled by direct-expansion ammonia coils. The temperature in this room was controlled by adjusting the expansion and suction valves.

In starting the test the temperature in the refrigerator was reduced to about 10 deg. and when conditions had become constant both inside and outside the test box the heating coils were started. The length of the test was one hour. Readings were taken every 10 min.

Preliminary tests were run to determine the effect of the temperature of the heat source on the results, and the time required for variations of the temperature in the test box to manifest themselves on the outside. It was decided to use the three coils which would be sufficient to maintain a temperature of 70 deg. in the box. The temperature of the coils was 170 deg. It was found that at least 2½ hr. must be allowed after external conditions became constant before internal conditions could be expected to become constant.

TABLE I. RESULTS OF TESTS ON 3-IN. CORK BOARD

No.	Item		1C	2C	3C	4C	5C	6C
		1	36.95	53.69	64.94	79.79	93.20	104.53
		2	36.68	53.97	64.04	78.53	91.84	103.93
		3	33.86	50.90	60.08	75.02	87.80	100.22
		4	8.33	12.65	11.20	14.18	17.96	20.12
		5	4.83	8.06	5.90	7.52	10.60	12.27
(1)	Temperature, deg. fahr., at thermocouple No.	6	4.86	7.70	5.54	7.07	10.40	11.93
		7	48.36	70.25	85.58	104.18	121.37	133.16
		8	5.66	9.40	8.14	10.27	14.00	16.16
		9	29.86	45.14	53.78	67.64	78.80	90.86
		10	6.56	10.40	9.23	11.30	14.90	17.39
		11	33.86	50.90	61.16	75.38	86.16	100.26
		12	6.09	10.04	8.24	10.94	14.18	16.68
(2)	B.t.u. per hr. supplied heater		70.62	100.00	136.26	166.16	197.69	226.66
(3)	Average conductivity through 3-in. material, B.t.u. per sq. ft. per deg. fahr. per hr.		0.102	0.098	0.105	0.104	0.106	0.109
(4)	Average conductivity per inch thickness, B.t.u. per sq. ft. per 24 hr.		7.34	7.06	7.56	7.49	7.75	7.85
(5)	Transmission* through 3-in. material, B.t.u. per sq. ft. per deg. fahr. per hr.		0.082	0.082	0.088	0.089	0.093	0.096
(6)	Transmission* through 3-in. material, B.t.u. per sq. ft. per deg. per 24 hr.		1.97	1.97	2.11	2.13	2.22	2.30

*Based on temperatures 2 in. from surface.
Density of sample 11.8 lb. per cu. ft.

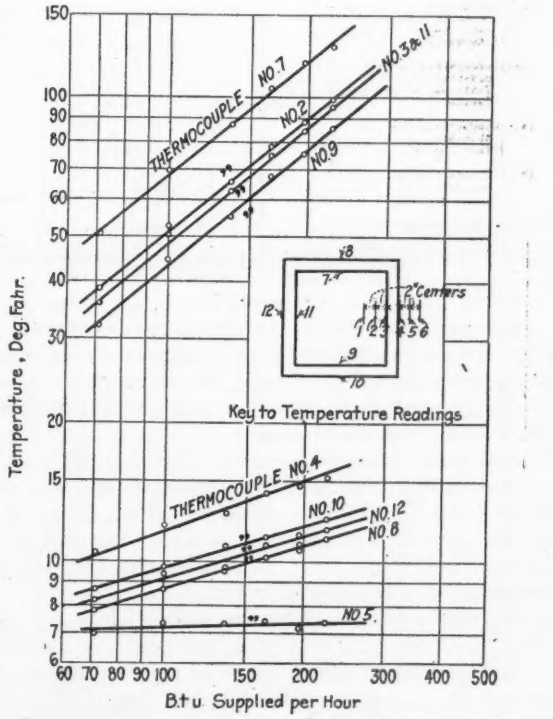


FIG. 2. TEMPERATURE READINGS OBTAINED IN TEST NO. 1

*From a paper presented before the American Society of Mechanical Engineers, December, 1920.

Test No. 1 consisted in keeping the outside temperature constant at about 10 deg. and raising the internal temperature. The mean temperature of the material was approximately 40 deg. F. The temperature drop through the cork was determined and the conductivity calculated. The results are as set forth in Table I and Fig. 2.

Test No. 2 was made in a similar manner with lith board replacing the cork on one side of the test box. The results are shown in Table II and Fig. 3. The conductivity of the lith board was figured from that of cork by comparing the temperature drop through these two materials. The relative conductivity of any two materials is proportional to the temperature drop through the specimen so that knowing the conductivity of one material we may find that of the other by comparing the temperature drops. Tables I and II show the final results of the heat conducted and the heat transmitted through these two materials. These tests indicate that the heat insulating property of cork board is about 5 per cent better than that of lith board.

TABLE II. RESULTS OF TESTS ON 3-IN. LITH BOARD

No.	Item		4L	3L	2L	2XL	1L	6L
		1	43.89	56.84	72.61	72.75	88.93	110.92
		2	42.80	56.66	72.37	72.50	88.16	111.38
		3	40.19	53.06	67.91	67.91	84.79	103.38
		4	11.03	14.00	14.90	15.35	16.34	16.07
		5	6.60	8.24	7.88	8.60	8.24	6.71
(1)	Temperature, deg. fahr., at thermocouple No.	6	6.53	7.88	7.70	8.33	7.79	6.62
		7	57.56	76.20	96.12	95.72	116.60	138.74
		8	8.00	9.92	10.39	10.60	11.39	10.49
		9	37.22	48.56	63.20	63.33	77.18	92.21
		10	8.60	10.69	11.66	11.75	11.75	11.75
		11	41.09	54.50	69.87	69.80	84.92	106.62
		12	8.60	10.64	10.99	11.64	12.20	11.75
(2)	B.t.u. per hr. supplied heater		87.85	116.66	153.70	153.98	199.16	249.85
(3)	Conductivity through 3-in. material, B.t.u. per deg. fahr. per sq. ft. per hr. (Method 1)		... ..	..	0.113	0.118	0.126	0.109
(3a)	Conductivity through 3-in. material, B.t.u. per deg. fahr. per sq. ft. per hr. (Method 2)		0.104	0.107	0.110	0.109	0.107	0.112
(4)	Conductivity per inch thickness, B.t.u. per deg. fahr. per 24 hr.		7.49	7.70	7.89	7.85	7.70	8.06
(5)	Transmission* through 3-in. material, B.t.u. per sq. ft. per deg. fahr. per hr.		.....	... ..	0.090	0.090	0.093	0.094
(6)	Transmission* through 3-in. material, B.t.u. per sq. ft. per deg. fahr. per 24 hr.		.....	.....	2.17	2.16	2.23	2.26

*Based on temperatures 2 in. from surface.
Density of sample 10.8 lbs. per cu. ft.

Average conductivity through 3 in. of material in B.t.u. per square foot per degree temperature difference per hour was found by equating the heat supplied (from the B.t.u. equivalent of the wattage supplied to the coils) to the heat transmitted.

$$H = 4\ C\ [(t_7 - t_8) + (t_9 - t_{10}) + 2(t_{11} - t_{12}) + 2(t_3 - t_4)]$$

H = heat equivalent of electrical input; C = conductivity, B.t.u. per 3 in. thickness per sq. ft. per deg. per hr.; 4 = area in sq. ft. of inside of test box. Temperature subscripts refer to locations as indicated in cross-section of box shown in Fig. 2.

Average conductivity per inch per 24 hr.:

$$C^1 = C \times 3 \times 24$$

Conductivity of lith:

$$C_1 = C \frac{(t_{11} - k_2\, t_{12})}{(t_3 - t_4)}$$

k_2 = the relation between the external temperature of the front and back sides obtained from the tests of series 1 = 1.3 average.

The United States Bureau of Standards gives the following values for the conductivity of cork board and water-proofed lith board:

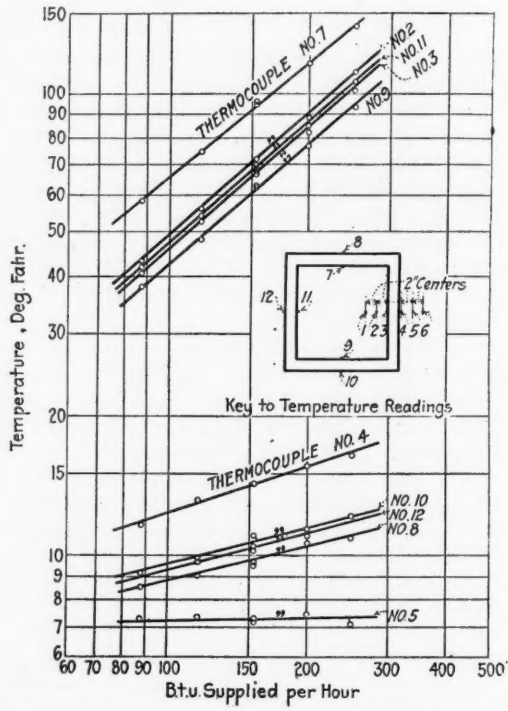


FIG. 3. TEMPERATURE READINGS OBTAINED IN TEST NO. 2

	Cork Board	Water-proofed Lith Board
Conductivity, B.t.u. per deg. per sq. ft. per 24 hr.	7.4	6.1
Density of material, lb. per cu. ft.	11.3	12.5
Mean temperature of material deg. F.	77	77

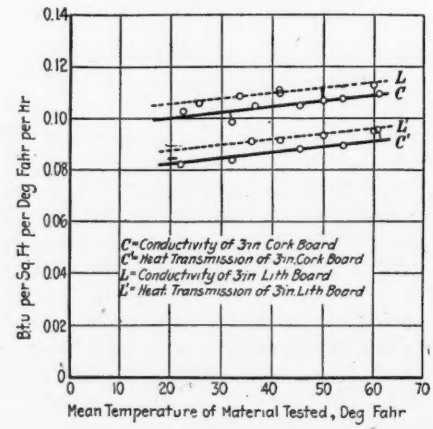

C = Conductivity of 3in Cork Board
C' = Heat Transmission of 3in Cork Board
L = Conductivity of 3in Lith Board
L' = Heat Transmission of 3in Lith Board
Btu per Sq Ft per Deg Fahr per Hr
Mean Temperature of Material Tested, Deg Fahr

FIG. 4. CURVES SHOWING CONDUCTIVITY AND HEAT TRANSMISSION OF CORK AND LITH BOARD

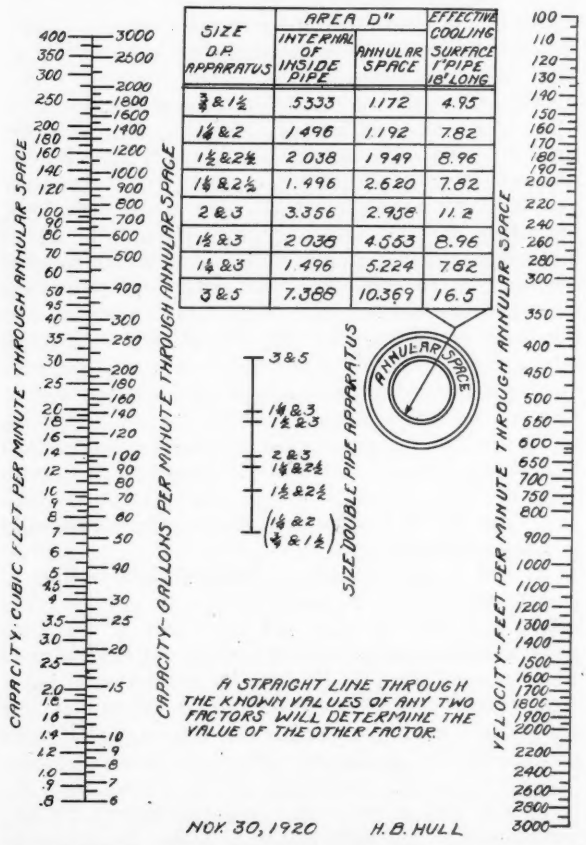
Increase in conductivity due to water-proofing is approximately 15 per cent, which is in direct proportion to the increase in density.

"THERE IS nothing so strong or safe in an emergency of life as the simple truth."

Velocity Chart for Double Pipe Condensers

By H. B. Hall

IN solving problems that have to do with the flow of fluids, liquid and gaseous, through double pipe apparatus such as ammonia condensers, brine coolers, distilled water coolers, water-cooled humidifiers, exchangers, dehydrators, weak aqua coolers, and absorbers, this chart will prove valuable in cutting down the computations necessary. It is used in determining the relation that exists between the rate of flow through the annular space in a condenser tube, the area of the space, and the velocity of the fluid. Knowing any two of the quantities, capacity, size of pipes, and velocity, the other may be quickly found by extending a straight line through the two known quantities to intersect the scale of the unknown where the value may be read directly.


SIZE O.P. APPARATUS
AREA "D"
INTERNAL OF INSIDE PIPE
ANNULAR SPACE
EFFECTIVE COOLING SURFACE 1" PIPE 16' LONG
¾ & 1½ .5333 1.172 4.95
1¼ & 2 1.496 1.192 7.82
1½ & 2½ 2.038 1.949 8.96
1¼ & 2½ 1.496 2.620 7.82
2 & 3 3.356 2.958 11.2
1½ & 3 2.038 4.553 8.96
1¼ & 3 1.496 5.224 7.82
3 & 5 7.388 10.369 16.5
CAPACITY-CUBIC FEET PER MINUTE THROUGH ANNULAR SPACE
CAPACITY-GALLONS PER MINUTE THROUGH ANNULAR SPACE
SIZE DOUBLE PIPE APPARATUS
ANNULAR SPACE
VELOCITY-FEET PER MINUTE THROUGH ANNULAR SPACE
A STRAIGHT LINE THROUGH THE KNOWN VALUES OF ANY TWO FACTORS WILL DETERMINE THE VALUE OF THE OTHER FACTOR.
NOV 30, 1920 H.B. HULL

AN ALINEMENT CHART FOR FINDING VELOCITIES IN DOUBLE PIPE APPARATUS

For instance, if we have a 2 by 3-in. cooler, what is the velocity of the fluid if the quantity moved is 10 cu. ft. per minute? Placing a straightedge on the quantities 10 and 2 by 3 we read the velocity as 0.487 ft. per minute on the velocity scale.

"The average man is sure that he is worth more than he's getting; the man above the average proves it."

Boiler Inspectors Meet

THE FIRST annual meeting of the National Board of Boiler and Pressure Vessel Inspectors brought together at the Hotel Statler in Detroit on Feb. 2, 3 and 4 a group of about 60 men, including members of the Board itself, members of the Boiler Code Committee of the American Society of Mechanical Engineers and others interested. Among the speakers were Dr. D. S. Jacobus, Charles E. Gorton, E. R. Fish, S. F. Jeter, F. R. Low and J. C. McCabe.

On the second day the members of the Board attended a meeting and took part in the deliberations of the Boiler Code Committee of the American Society of Mechanical Engineers. This meeting of the Committee was held at Detroit instead of, as usual, at the headquarters of the Society in New York, in order to give the Committee the advantage of meeting and counseling with the men from all over the country who are enforcing the Code. Nineteen inspectors were present from almost as many different states in widely separated sections of the country.

Joseph F. Scott, inspector from New Jersey, is to continue as chairman of the National Board and C. O. Myers, of Ohio, as secretary-treasurer. The objects of the Board of Boiler and Pressure Vessel Inspectors, as stated in the constitution adopted, are as follows: To promote uniform boiler laws and rules throughout the jurisdiction of its members; to secure uniform approval of specific designs of boilers and other pressure vessels as well as appurtenances and devices used in connection with their safe operation; to promote one uniform code of rules and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for inspectors who are to enforce the requirements of said code; and to compile official statistics and other data.

Our Reserve Oil Supply

Local engineers have been stating for some time that our shale deposits in Colorado could be utilized in stocking the market with a splendid grade of crude oil, but as usual there have been many doubters.

In a recent meeting of the American Chemical Society, Prof. Ralph H. McKee, of Columbia University, and E. E. Lyder, chemical expert, read a joint paper entitled "Heat Factors of Oil Shale Distillation," and they told us that the supply of shale in Colorado was enormous; that only slight inroads have been made into it, and that within 10 yr. millions of gallons of crude oil will be available and that the shale deposit is capable of producing 10 times as much oil as we have obtained from our wells.

Our oil shales are an endowment of inestimable value on which we are certain, ultimately to depend heavily, though the time and rate of that dependence will be largely controlled by the prices of natural oil.

During the meeting of the American Mining Congress held at Denver during November, 1920, it was the opinion of many engineers present that the shale oil industry means for Colorado what coal did for Pennsylvania.

J. B. Dillon.

Uniform Boiler Inspection Laws

ADVANTAGES SOUGHT AND DIFFICULTIES ENCOUNTERED IN ENFORCEMENT. BY C. O. MEYERS*

COMPULSORY inspection of steam boilers became effective in the state of Ohio on Jan. 1, 1912, and was the direct result of an active campaign on the part of the stationary engineers, who for years had been entrusted with the care and management of steam boilers, and were directly responsible for their safe and economical operation, but who were for various reasons, no doubt well known to all engineers, to obtain the supplies or repairs necessary to secure best results toward safety in their operation.

They took it upon themselves to bring together all the interests affected by compulsory boiler inspection, and voluntarily financed the movement, with the result that today we have a boiler inspection law in Ohio that is second to none, and we find purchasers of boilers in states where there are no boiler inspection laws specifying Ohio Standard when buying new boilers, knowing that thereby they will secure boilers that are absolutely right as far as material requirements and workmanship are concerned, and that they have been thoroughly inspected in the shop during construction by a qualified Ohio boiler inspector who is in no way interested in the manufacture or sale of such boilers.

There are 57 shops in the state of Ohio and 93 located in other states, a total of 150 shops, authorized to manufacture Ohio Standard boilers. There are 232 inspectors regularly qualified to make boiler inspections in accordance with our requirements. About one-half of these inspectors reside in the various states where Ohio standard boilers are built, and are in the employ of boiler insurance companies, and they make the required shop inspections in those states.

During the fiscal year ending June 30, 1920, 5126 Ohio Standard boilers were constructed and data reports for same filed with our department. The annual report for the Ohio Boiler Inspection Department shows that we received more than 25,000 reports of inspections. We issued during that time 19,100 certificates of inspections; 110 boilers were condemned as unsafe for further use, due to age, deterioration, and defects in constructional requirements, and it is interesting to note that out of this great number of boilers inspected, only 2958 repair orders had to be issued, showing that owners and users of steam boilers in Ohio are co-operating with us, and are complying with every requirement of the Ohio boiler inspection law and rules.

The Ohio Board of Boiler Rules and the Inspection Department were made a part of the Industrial Commission of Ohio in 1913. At this time very few states had boiler inspection laws, and as this went on other states saw the necessity of boiler inspection and enacted similar laws until we now have 13 states, 1 county and 11 cities operating such laws.

These laws vary to a great extent insofar as the construction and installation is concerned, making it difficult for the manufacturer to build a standard boiler, and for the user to interchange a boiler from one state to another. It is necessary for the manufacturer who is building a boiler to be used interstate to build it so that it complies with all the standards and stamp it with all such state standard stamps. Our attention has been called to some small boilers built in this manner which required 12 different stamps covering the entire fronts of the boilers.

The attention of the Industrial Commission of Ohio was called to this condition, and in order to promote uniformity and interchangeability between states, this Commission requested the governor of each state to appoint a representative to attend a uniform Boiler Code Congress at Washington, D. C., Dec. 4 and 5, 1916. Twenty-four states and four cities accepted this invitation and the records of this meeting show that all the states and cities present signified a willingness to accept the code formulated by the Boiler Code Committee of the Council of the American Society of Mechanical Engineers, when enacting such legislation in their respective states.

Since that time a number of states have enacted boiler inspection laws, and have accepted these rules for their standard construction, and it was thought by the adoption of this code that the question of uniformity and interchangeability between them would be solved, but after putting this code to the practical test of enforcing its provisions it has been found that it requires perpetual interpretations and as these interpretations are merely the opinion of the Boiler Code Committee, it is not compulsory for the inspectional departments to accept them, and this committee is not invested with the legal power and authority to enforce its rulings. This has created a condition which was not looked for at the time of the meeting of the Boiler Congress and is creating a varied difference in enforcing the provisions of the A. S. M. E. boiler code, and is, therefore, destroying all the benefits to be derived from uniformity and interchangeability.

It will be my endeavor to point out the position of a state official and the responsibility he assumes when taking his oath of office and the effect of enforcing rules which are formulated by persons not charged with these responsibilities. It must be remembered that a public official is responsible for the conditions that may exist in the locality under his supervision, and it is an easy matter for persons who have never been in such a capacity to assume that there are no limitations to the acceptance and enforcement of regulations, and, further, you must not lose sight of the fact that the authority invested in a state official by law cannot be delegated by him to other persons, particularly so when such persons are not residents of his community.

With these conditions existing it is only natural to expect that each official, after accepting the American Society of Mechanical Engineers boiler code, will interpret and enforce it in accordance with his own individual ideas, and this is his right, as he, when accepting this code, accepted it as it is understood by him. Here is the condition that now confronts us. We have a code of rules formulated by persons who have not the

* Chief of the Division of Boiler Inspection for the State of Ohio.

legal authority to enforce them and enforced by persons who have this authority. Inasmuch as the enforcement of rules is the most essential, it is necessary that there should be an association of these officials who are charged with the enforcement of these rules in order to accomplish uniformity, and before we can progress much farther some means must be provided whereby these officials may know what each other is doing, and before any action is taken on any case separately we may have it thoroughly discussed collectively, and if its merits permit, have it accepted and enforced by all states uniformly.

The Ohio Board of Boiler Rules, seeing this condition and realizing that the more states that adopt the A. S. M. E. boiler code, and are added to the existing list, the greater will be the problem which will have to be solved at some future date, and that uniformity can never be had until such time as there is a board created which will have the legal authority to enforce its rulings, and as they are in a position to see the absolute necessity for concerted action by all legally constituted boiler inspection departments, and believing that it is to the best interests of all concerned, has suggested the organization of a board with a membership consisting of those who are charged with the enforcement of boiler inspection laws.

This board was organized Dec. 2, 1919, New York City, and is known as the National Board of Boiler and Pressure Vessel Inspectors, and at the present time consists of 22 members. This board as it is now constituted has the executive power and authority to enforce its rulings and interpretations, and any action it will take will have the full force and effect of law which is absolutely necessary to enforce any rule or interpretation that may be made.

While all of these interests have been working separately, I am strongly of the opinion that the only way results can be accomplished is by getting all these interests together with state officials around a table and have a thorough understanding so that all will work together collectively towards securing complete uniformity in the construction. installation and inspection of steam boilers and their appurtenances.

Reducing Coal Consumption

By J. L. Young

THE MATTER of conserving coal is one of the greatest considerations which an engineer has to handle at this time and various lines of industry call for different methods of handling.

A central station engineer will take more pride in holding down the cost per kilowatt-hour while the engineer in an industrial or manufacturing plant will no doubt try to hold down the current consumption as well as the cost per kilowatt-hour.

We often wonder why this cost varies so in plants of seemingly the same capacity; but in totaling the matter up, there are hundreds of reasons. A good installation may be handled in the best possible manner in one plant, while in another it may be poorly handled. One man may be operating under ideal conditions while another may be handicapped. One may have at his disposal permission to buy the best equipment and repairs, while another would not get them with all the pleading in the world because the plant was still running and would probably hold out another week or so.

Such are the different operating conditions; but in all cases the writer is led to believe that if the engineer in charge will take care of what he has under his care and of the new equipment which he receives, he will not have this difficulty.

We are now going through a period of readjustment and a great many plants are operating on a reduced schedule. We are not all lucky enough to have the most economical plant to operate under such conditions and, being in this class, I want to say that I know of no better time than the present to make an extra effort in conserving. Go through your plant and analyze it; see whether you cannot see a place where energy is being wasted; a motor may be running that could be discontinued by a few changes; you may have a number of electrically heated machines not in use with the current still on; a light that is not needed may be burning in some corner; a suggestion to the right person might save 20 per cent of your elevator trips, and so on.

These are the things which the engineer can handle without asking the employer for help. In many places an operator may leave his machine in midday not to return until the following day; the energy used at such a place is lost unless watched very closely. Make it a rule that each operator or person in charge of such machinery does this and turns out the light he uses also.

Some will say, "Well, I would, but I can't get them to do it, and my men haven't time and the foreman in charge doesn't care for my expense."

This is a poor excuse. I find that if you will take it easy at first and give them credit for what they do, show them what it means and that you appreciate their help, you will suddenly be going along nicely and wonder how you did it.

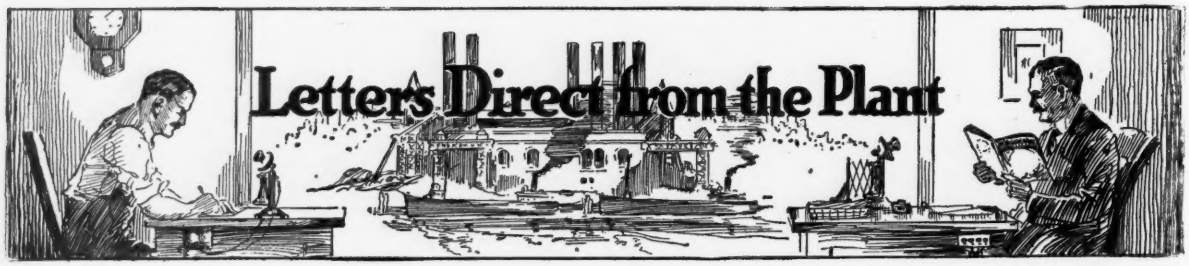
Did you ever go into detail and show them what it means to turn off a light a few hours a day or energy of any sort? If you did, you probably said something about those kilowatts and after you were gone, they wondered what you really meant.

Devise some way of getting this clearly in their minds. Try this. Get a small hand generator of some sort and connect to it a 40-w. lamp of the proper voltage and install in some location where the employes assemble during noon hour, and with it hang a sign reading something on this order:

"Turn the crank and make the lamp burn bright and at the same time bear in mind that this size lamp left burning unnecessarily 2 hr. each day for 30 days consumes from 20 to 40 lb. of coal."

Most people are glad to help in such matters after they once clearly realize the energy expended in the different operations; but unless the matter is brought pleasantly and clearly to their minds, this loss and waste will go on day after day, not because your operators do not care for your end of the business, but because electric energy is so handy and quiet in its work that a thought had never been cast toward this manner of saving.

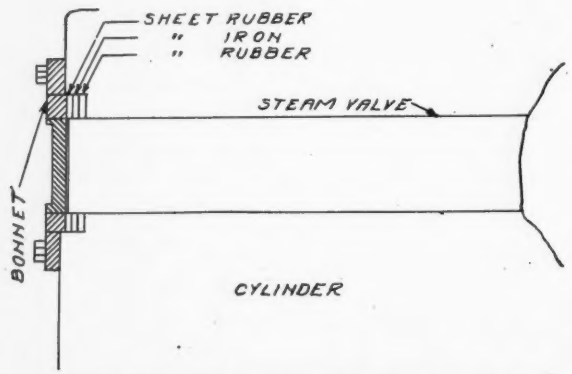
In all cases, don't be afraid to give the right person or department, as the case may be, the credit they deserve in saving and your monthly or daily report will tell you that your efforts were not in vain.



Corliss Steam Valve Too Long

I READ the article entitled Dry Valves by A. C. Waldron, on page 1193, Dec. 15 issue, with much interest and wish to say that I had an experience similar to his with a 16 by 32-in. Corliss engine. New steam valves were placed in the cylinder after the valve ports were rebored. The new valves were fitted and placed one Sunday and the engine run for an hour or so. All seemed to be in first-class order to start up again Monday morning without any trouble.

Monday morning all went well until about 10:30, when the engine started to pound badly. In looking for the trouble I noticed that the steam valves did not drop entirely down to close the steam ports; first one, then the other. At first I thought that the valves were dry, but feeding more oil to the cylinder with the lubricator and oil pump did not remedy the difficulty. Then



SECTION THROUGH CORLISS STEAM VALVE BONNET

I thought the air valves on the dashpots needed adjusting, but with no better results. The pound in the engine became so bad that it was necessary to shut down the engine. After shutting down the engine, I found that the valves moved very hard when turning them with the starting lever, and I was sure there was something wrong with the lubricating ways of the valves which were clogged up from some of the boring chips that had remained in the ports or the oilways were not cut as they should be for the valves to receive proper lubrication at all points. The back bonnets were removed from the steam valves and the valves taken out, when I found that the valves received sufficient oil when they turned in the valve ports, but that the ends of the valves were bearing quite hard against both bonnets, which caused them to stick up, as no oil got there; but the trouble was caused most by the valves being a little too long, and after the engine had run a number of hours, they had expanded to such an extent that they bound between the two bonnets when no lubrication could get there; hence they were bound to stick.

As there was no time to take the valves to a machine shop and have them shortened so they would be of right length, I got out of the difficulty in the following way until there was an opportunity to have the valves shortened without again shutting down the plant during working hours: The gaskets used on the back bonnets were about 1/32 in. thick. I increased this thickness to about 3/32 in. by first placing one gasket of rubber next on the bonnet, then a gasket of sheet iron on top of the rubber gasket, then another rubber gasket on top of this sheet iron gasket, as shown in the illustration. This made the space between the back bonnets longer, hence the valves could expand without binding.

I used the gasket made out of sheet iron between the two rubber gaskets because I was under the impression that if I used three layers of the 1/32-in. sheet packing for the gaskets, they perhaps would have compressed enough after drawing up on the bonnet cap screws to bind the valves again, hence I wanted to make doubly sure this time that I would not have to shut down again when getting started.

The engine ran this way without any more trouble until the following Sunday, when the valves were shortened to the right length at a machine shop.

H. A. JAHNKE.

Frozen Drop Pipes

ON PAGE 144 of the Jan. 15 issue, C. E. Anderson states that if the temperature in the engine room is below 75 deg. F., merely heating the air to that degree of temperature or more will eliminate the precipitation in the drop pipe. I agree with Mr. Anderson, but believe this would necessitate a considerable outlay of money, particularly in the case of a steam plant (housed in a frame structure) changed over to electric drive and with an outside temperature around 0 deg. F. Many such plants can with advantage retain their feedwater heaters, which can be utilized to heat the air. This can be placed beyond the blower and the heat produced in compressing the air can be employed to assist in raising the temperature of the air, thus resulting in the saving of at least a little steam.

I have in mind a plant where a closed feed-water heater is used to heat the air. First this was connected between the tank and the blower but after that was changed so as to heat the air before it enters the blower. It is now so arranged, eight ells, a 45-deg. fitting and about 30 ft. of suction piping being used. The heating of this system results in much expansion and consequent trouble. Before the above change was

made, but two ells and approximately 6 ft. of piping were in use.

I wish some of the readers of Power Plant Engineering would show me when it is better to heat the air ahead of the blower.

Usually 2 lb. pressure is sufficient to agitate the water, but at times the cans will float at different levels as some cans are filled more than others. This will practically suspend agitation or at least so retard it as to cause the moisture to precipitate and freeze; however, raising the pressure 4 or 5 lb. will help matters somewhat. This may be accomplished by either increasing the speed of the blower or reducing the size of the orifice, thus increasing the pressure.

Heating the air is much in practice, but I will say that the air used for circulation in raw water ice plants should not be heated either ahead or back of the blower.

Firing hot air into the water in the can heats the water and retards freezing. Accepted practice recommends cooling the air previous to going to the cans.

FRED W. SCHNEIDER.

Water Distiller

MOST POWER plant engineers have in their charge storage batteries, either for automobile or factory auxiliary current, which require the use of distilled water. The accompanying sketch illustrates how a water still can be made in the plant out of a piece of 10 or 12-in. copper pipe with heads brazed on. The tank shell should be ¼ in. thick with humped heads and be provided with

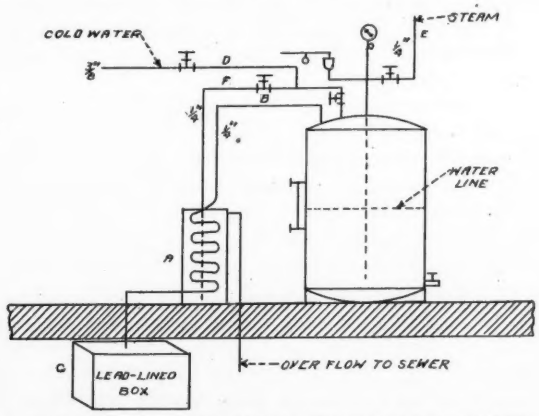


DIAGRAM OF APPARATUS USED TO DISTIL WATER

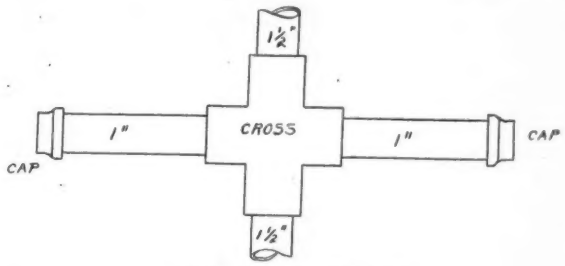
a gage glass on the side. An open tank, A, must be provided; this is kept full to overflowing with cold water for condensing purposes, and contains the coil which is easily made of ¼-in. copper tubing. A lead-lined tank, C, is provided to catch the condensed distilled water.

To operate the device, fill the tank with water up to the center of the gage glass from pipe D; open steam valve in pipe E which goes to within 3 in. of the bottom of the tank. This steam boils the water at low pressure and the resultant steam flows through pipe B into the condensing coil. The condensate drips into the lead-lined tank C ready for use. Cooling water comes through pipe F. Five pounds steam pressure in the big tank is sufficient for the purpose. To dip the distilled water a clean glass or porcelain pitcher serves well.

SAM BOW.

Pipe Ladder for Industrial Plants

THE ARTICLE by Henry Brady on page 124, Jan. 15 issue, describes a ladder for power plant use. On account of the castings for the steps, it is not likely that this ladder will be used in many of the smaller plants. A pipe ladder which can be made complete with the tools used in most plants, no matter how small, has been in use for many years and has given satisfaction. It can be made by using 1½ by 1-in. crosses, and caps and iron pipe, no castings, outside of the bottom and top standard flanges, being required. The accompanying



DETAIL OF PIPE LADDER

sketch shows the idea. The principal thing required in building this ladder is to see that the crosses are screwed tightly to the pipe. I would not recommend the nuts on the U bolts in Mr. Brady's ladder. If a man should slip a bit, he is likely to get a bad bruise from these nuts and bolt ends.

JAMES E. NOBLE.

Pipe Bending Hints

IN BENDING large pipe, fill with *dry* sand and plug the ends. Heat to a red heat in localities to be bent and bend. Be sure that the sand is *dry*. Where bends are slight, it is often unnecessary to use sand or resin. The object of sand or resin is simply to keep the sides of the pipe from collapsing, or to prevent reduction of flow area. If wet sand is used, and if the ends are plugged, the pipe may burst when heated, due to the steam pressure generated.

Resin, also, is good. There is, however, a "right way" and possibly several wrong ways to use it. An example of a wrong way was recently brought to my attention where the mechanic filled the pipe with resin, plugged the ends, and heated the pipe at the place where he wanted to bend it. He watched for a "red heat" just as he would had he filled the pipe with sand. The result was—a violent explosion.

The way to use resin is to pour it into the pipe and allow it to cool and harden. As soon as the resin is hard, bend the pipe *cold*. Don't heat it. Then, after the pipe is bent, heat the pipe all over sufficiently to melt and remove the resin.

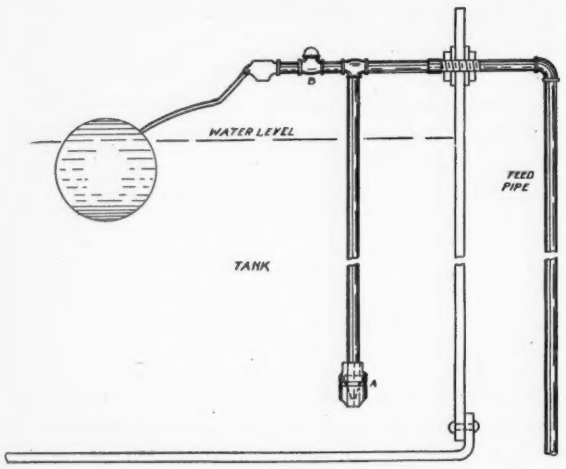
There are many excellent mechanical devices on the market for bending pipe. To bend large, stiff pipe slightly, and inexpensively, there is nothing handier or more efficient, in my judgment, than a hydraulic pipe bender driven by a hand pump.

W. F. SCHAPHORST.

"TODAY is short; yesterday is gone; tomorrow may never come. If you've got anything to do; get busy."

Providing Water for Use Nights

THIS DOUBLE supply water outfit shown herewith was described to me and I see no reason why it will not work as long as valve B remains tight. The supply going through the ball cock is turned on all day, but closed off at night. The different fixtures throughout the building are supplied through branches taken from the feed pipe before it reaches the tank. During the day, enough water enters the tank to fill



TANK PIPING FOR DOUBLE SUPPLY WATER SYSTEM

it to the level shown. When the valve is closed at the bottom of the feed pipe, the water is siphoned from the tank up through valve A and then to any tap which may be opened below. J. E. JAMES.

Cedar and Its Uses

UNDER THE title of "Waste of Cedar Wood," page 156, Feb. 1 issue, J. B. Dillon makes some statements which grossly exaggerate conditions. First of all, very few cigar boxes are made of solid cedar, only the 25c variety, as a rule, being honored with a solid box. Most boxes are made of veneer and have been for over 40 yr., the veneer being exceedingly thin—about 1/50 in.—sometimes glued to a cheaper corewood. The waste, therefore, is not so great as it appears. Second: Exceedingly few boxes are made of cedar; in fact, I have never seen one made of any kind of cedar. The wood used in cigar boxes is Spanish cedar (Cedrela odorata) and is really not a cedar at all, but a broad leaf tree of the mahogany family. It comes from Mexico and Central America, and is used because its odor is supposed to impart a better flavor to the cigars.

The cedar used in pencils is commonly known as red cedar (Juniperus Virginiana) and is really a juniper. The same tree yields some of the juniper berries of commerce. It is true that the supply of juniper berries or red cedar is sadly depleted, but pencil manufacturers have found an excellent substitute in the incense cedar of California (Libocedrus decurrens), and of this there are vast quantities from the standpoint of using it all for pencils. California redwood is also coming into extensive use for cigar boxes. Much misinformation and much confusion results because of the loose use of the word "cedar." Any tree that looks like a cedar in any respect, or whose wood smells like cedar, has come to be known as a cedar to the layman. The application of the name cedar to the common cigar box wood from the sub-tropics can be defended only because custom has so long recognized it, even though it is wrong.

EMANUEL FRITZ.

Trouble in Fire Alarm Relays

THERE ARE many uses to which fire alarm relays of various sizes (patterns and resistances) are put around factories. Some of the prominent troubles that occur in these instruments are residual magnetism and binding of the armature in the trunnions.

Whenever residual magnetism—of sufficient strength to cause the armature to hang—is present in cores operated by such small current as these relays require, it indicates that the iron has become hardened and about the best cure for that is to remove and place another relay.

If the trouble is caused by a hang, or bind, in the trunnions, then that can be remedied by taking the armature out and using a little "Omy" cloth, carbona, or gasoline to remove the grit, or rust that has formed. Be sure that the armature axis is dried carefully ere you replace, especially if you use gasoline, or a new rust will form shortly. There is no need for such precautions when using Omy, or carbona. Never use sandpaper or emery cloth to do this work, for no matter how careful you may think you are, you are more than likely to spoil the instrument by causing an unevenness, and whenever that exists in instruments of this class you may expect trouble.

A simple test to distinguish which of the two causes mentioned is causing our trouble is to remove the "battery" run the relay spring down until just the weight of the spring affects the armature, and if the armature does not respond, but shows a tendency to "stick," then widen the path between the front and back stops and take hold of the top of the armature and gently draw it away from the magnet, or, in this case, the cores.

If the armature remains in any position when you remove your finger tip, the trouble is due to binding in the trunnions; but if it drops back to its contact nearer the core and does so quite readily and offers a slight resistance in being pulled away, your trouble is due to residual magnetism.

The eye will often pick out the fault readily, and of course a bent armature axis, a trunnion base slipped out of position, will cause the hang; still, trouble of this nature is so obvious, though seldom happening, it is not necessary to dwell upon treatment.

Withal, it is the little things that often cause us the most trouble and we so often overlook them in hunting for something big.

It cannot be too strongly stated that if we expect good results, these armatures should rest at an angle of 90 deg. when in their "closed contact position."

J. B. DILLON.

A PAPER CHIMNEY, 50 ft. high and fireproof, is a curiosity to be seen in Breslau.—Compressed Air.

The Exhaust Cam Moved Forward

It is no uncommon thing to have an eccentric slip backward, but would it not be some phenomenon if it slipped forward! Recently a case came to my attention where the exhaust cam on a large engine slipped forward. When the engine was stopped for adjustment (the first time the cam slipped) the cam was found to be about 70 deg. ahead. Of course, it did not seem possible for it to have slipped 70 deg. ahead, so it must have

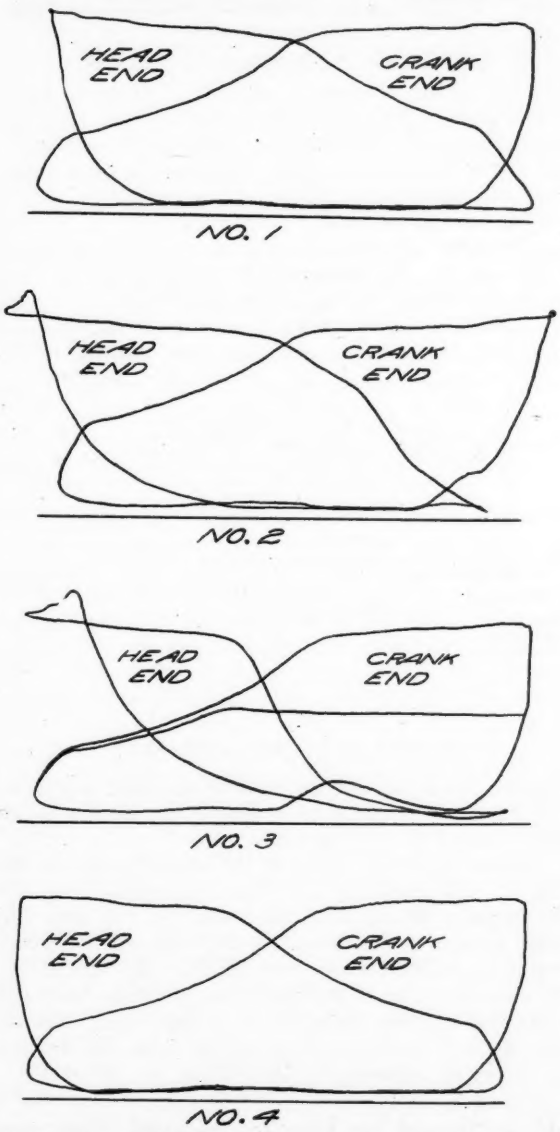


FIG. 1. CARDS SHOWING THE EFFECT OF ADVANCING CAM

slipped backward 290 deg. But it was caught in the act at the very start on the second offense and the indicator cards furnish positive proof.

Card No. 1 shows the compression on head end just beginning to increase and forming a little loop on the very top. The release, also, is earlier.

Card No. 2 shows the compression increasing quite rapidly, forming a larger loop on steam line above boiler pressure. Release is very early.

Card No. 3 shows quite a decided change for the worse. The compression has taken a boost and gone away above the steam line. The release now is where the expansion line ordinarily would start. This early release from 140 to 6 or 8 lb. builds up the back pressure and puts a curve in the exhaust line of the crank end card that makes it look like an overshoe.

It also causes a pound in the pins that makes the engine sound like a pile driver.

Card No. 3 was taken just as the engine was being stopped at noon and the throttle was being closed. The line through crank end is the steam line as a close inspection will show. It runs into the expansion line and is about the third marking of the pencil. An extremely long cutoff at this pressure gives a high pressure at release and the steam in exhausting seems to kick valve gear and throw the cam forward. It won't again, as the shaft is spotted now.

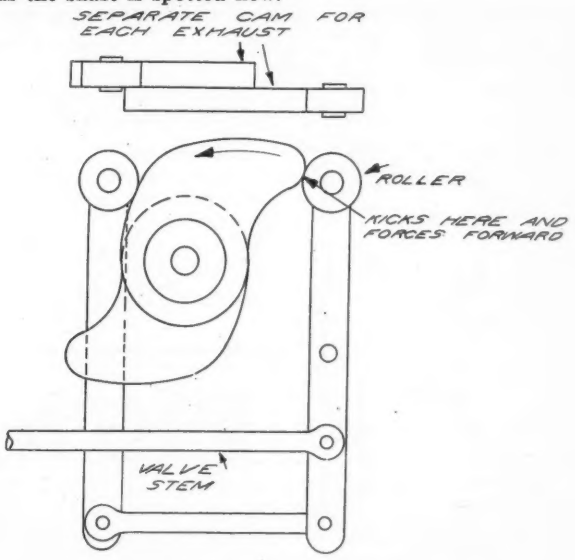


FIG. 2. HOW THE CAM WAS MOVED FORWARD

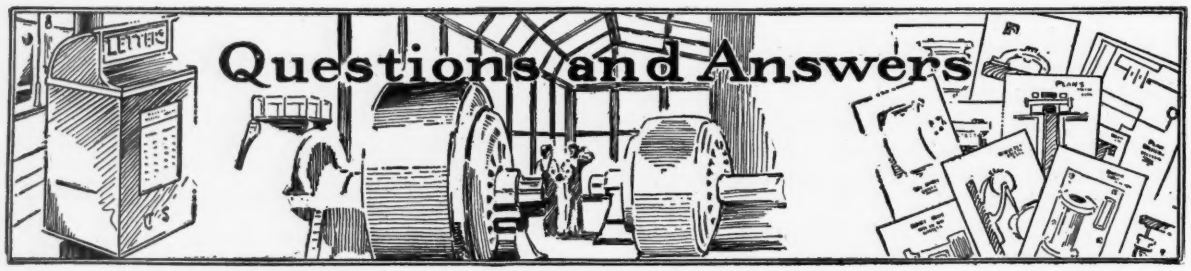
Card No. 4 is the result of 15 min. work and shows the engine developing 1208 hp.

This is one side of a 30 by 60-in. double Leavitt and has been in constant operation 32 yr., a good part of the time 24 hr. a day. The maximum output is approximately 2500 hp. and all exhaust is used for feed water heating and in the process of manufacture.

Tom Thumb.

The Clay Products Co. of America will build a new electric power plant in connection with its brick manufacturing plant at New Hope, Pa., estimated to cost about $900,000, with equipment. In addition to brick-making machinery, the installation will include an industrial railroad system and hoisting and conveying machinery.

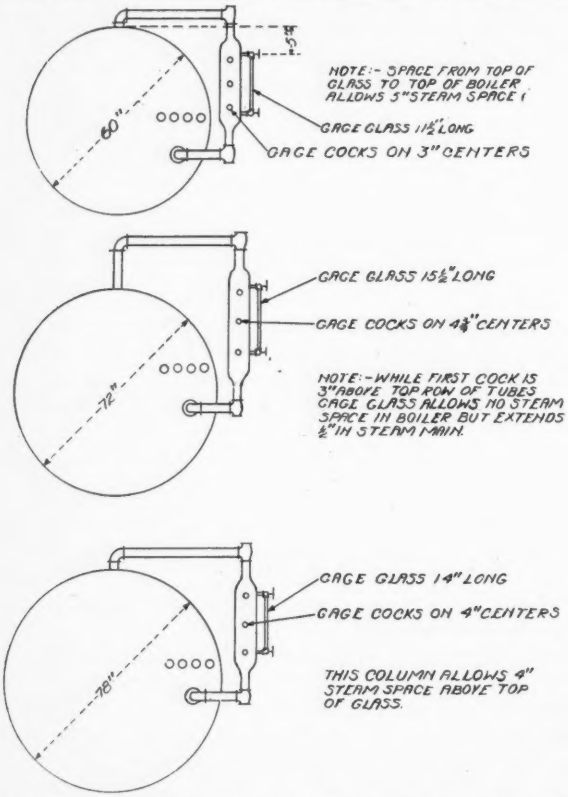
An entirely new use for coke breeze has been discovered in East Ashland, Kentucky, where a storehouse has recently been built of coke breeze blocks. The breeze was obtained from an adjoining coke oven plant and blocks were made by mixing coke breeze and cement in proportions of two wheelbarrows of breeze to one sack of cement.—Iron Age.



What Length Water Column Would You Use?

How CAN you tell whether a water column is of proper length?

From accompanying sketch you will see that there must be some rule for allowing steam space above the glass, also that columns vary in length. I have asked everybody I knew whom I thought able to answer this


NOTE:- SPACE FROM TOP OF GLASS TO TOP OF BOILER ALLOWS 5" STEAM SPACE
GAGE GLASS 11½" LONG
GAGE COCKS ON 3" CENTERS
60"
GAGE GLASS 15½" LONG
GAGE COCKS ON 4⅜" CENTERS
72"
NOTE:- WHILE FIRST COCK IS 3" ABOVE TOP ROW OF TUBES GAGE GLASS ALLOWS NO STEAM SPACE IN BOILER BUT EXTENDS ½" IN STEAM MAIN.
GAGE GLASS 14" LONG
GAGE COCKS ON 4" CENTERS
78"
THIS COLUMN ALLOWS 4" STEAM SPACE ABOVE TOP OF GLASS.

ILLUSTRATING VARIATION OF WATER LEVEL WITH VARIABLE COLUMN LENGTH AND BOILER DIAMETER

but with the same results, all saying they never heard of any rule, yet agreeing that there must or should be one. I am convinced that there must be a rule. What is it?

Pointers on Gas Engine Operation Wanted

I WISH some of the engineers who have, or have had, charge of gas producer plants and operating gas engines, for the generation of electricity would write of their experiences for publication in Power Plant Engineering.

This seems a subject warranting greater consideration than at present given by the technical papers.

L. E. H.

Is Homemade Economizer Practicable?

I WOULD like opinions on a project I have in mind at this plant. We are pulling a load of 1400 hp., furnishing steam for four slashers, heating a 36-room hotel, also steam heat for the mill. We run day and night. Our water scales rather badly. I run six 150-hp. boilers and have one spare boiler.

I have an open feed-water heater which heats water to 200 deg. F. The owners of the plant do not want to go to the expense of buying an economizer, so I wish to install a heating coil in my breeching. As indicated by the sketch, this is to be suspended at the top part of the

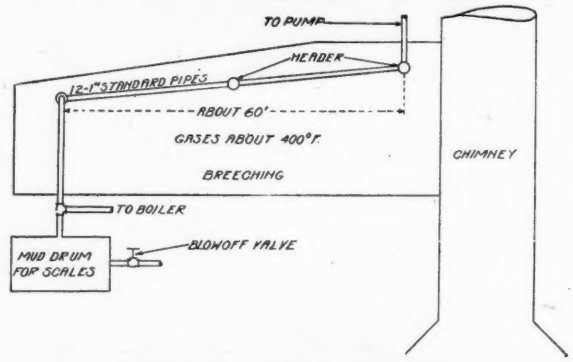


DIAGRAM OF PROPOSED ECONOMIZER

breeching so as not to interfere with the draft any more. I will possibly install a blow pipe along the side of the coil to keep it clean of soot also.

Water to go into pipes at the highest point at 200 deg. F. and gradually go down the inclined pipe in the opposite direction to the gases, by the time this watre arrives at the lower header it should be almost wet steam with all scales precipitated. My idea is that the scale would go to the mud drum provided for it and clean and very hot water will go to the boiler. The old arrangement would not be interfered with, but the feed water simply bypassed to new system. H. S. D.

What Should He Use for Blowoff Pipe and Fittings?

PART of our boiler plant consists of five 78-in. horizontal return tubular boilers and on going over them a few days ago I found the feed lines in the smoke boxes where the line turns with a 90-deg. elbow to go into the boiler head completely eaten away on the outside of the pipe to a point of almost paper thickness, and that not in one boiler, but in all of them. The feed line to each boiler is 1½-in. extra heavy brass pipe and I found on looking up on the records that these lines were less than 2 yr. old.

I told the master mechanic that I would like to renew the pipe and elbow with extra heavy steel or iron pipe and an extra heavy steel or malleable iron elbow on the two short pieces exposed to the gases; but he said I was wrong and was surprised that I should show such poor judgment.

I quoted the fact that the blowoff pipes were extra heavy iron and a 1500-lb. steel elbow and had been in for 6 yr. exposed to much worse conditions even though protected by a V-shaped brick wall.

Would an asbestos covering over these pipes help, these to be removed and replaced on each inspection?

I would like to get a few opinions on this matter, as a burst feed line is a mighty mean thing to be caught with under 160 lb. of steam and no way to shut it off.

W. S. H.

Pump versus Trap Feed

IN THE Dec. 1 issue, page 1149, under "Feed-Water Heaters," appears the question, "What is the best method of feeding water to a boiler, a pump or direct-return steam trap?"

On page 143 of the Jan. 15 issue, H. Armstrong in answer says: "If I had a system of any size, I would never put in a gravity system and on large installations would prefer a vacuum pump that will make delivery to an automatic receiver to which the feed pump is connected."

I would ask Mr. Armstrong why he would not use a trap feed on any system where returns from a heating system were to be returned to the boiler. The trap system is simple, readily understood by almost every engineer and with the best return traps made today why not install one? There certainly are some advantages in using a trap feed. A steady water level is maintained and a more even steam pressure is carried. The condensed steam is returned to the boiler at nearly the same temperature of the steam from which it was condensed. It has not been exposed to the air and consequently has not lost its heat in vapor. The fuel saving depends upon the apparatus drained, and it will be about 1 per cent for every 10 deg. F. increase over the present temperature of water fed to the boilers. There is no operating cost, as it does not exhaust any steam, while a steam pump uses about 8 per cent of steam from the boilers. Feed water comes in at a higher temperature, which avoids so much strain on the boilers. The trap system can be used on a vacuum system by using a vacuum trap.

W. L. N.

What is the Cause of the Drop in Vacuum?

AT OUR municipal pumping station we have two pumping units, one of 4,000,000 and the other 6,000,000 gal. The first engine is 15 by 23 by 33 by 17 by 24 in., and the second 16 by 25 by 42 by 19 by 36 in., pumping from a well system of 30 12-in. wells at an average depth of 40 ft., with a 20-in. suction line extending along river shore about 1600 ft. When the pool is full, or nearly so, a vacuum of 28½ in. can be maintained; but if pumps are speeded up quickly it will fall to 20 in. and pumps will begin to hammer, but eventually the vacuum will rise and pumps will go along smoothly at the increased speed. I would like to know whether this is an indication of a leak in the suction line or an indication of insufficient water supply. If a leak, how can I best locate it? I have located one break by pumping ether into the suction line; but as it comes out of the ground at the easiest place, it is hard to trace.

I am also troubled with oil sticking to my surface condenser tubes, although we have an eliminator attached. Our method of cleaning is to drain the condenser and discharge line and heat it up with steam, cooking the grease off; but stopping pumps is not always convenient, as our consumption demands continual pumping. Is there some other way that this grease could be removed?

I would appreciate the suggestions of some of your readers on this subject.

E. D. J.

Why Excessive Back Pressure: 45-deg. Elbow

ON PAGE 190, Feb. 1 issue, I notice H. M. R.'s "Why the Excessive Back Pressure?"

I am enclosing a card from a 30 by 60-in. engine and if he thinks the cards are quite similar (his and mine), he may do as I did to overcome the difficulty.

I rebored the cylinder, made a new piston and ring,

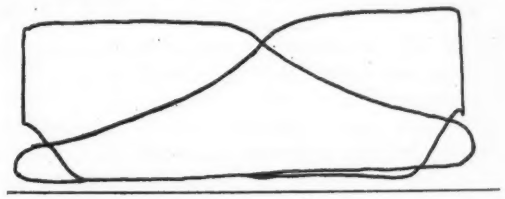


FIG. 1. CARD FROM 30 BY 60-IN. ENGINE

and then everything was O. K. His card, cutting off at a trifle over one-quarter, has a chance to make the loop, but mine is such a lot more (nearly one-half) that no loop is possible. The steam blowing past the piston would raise the receiver pressure. In my case, the engine exhausted into a low pressure and could not possibly accumulate above ten pounds.

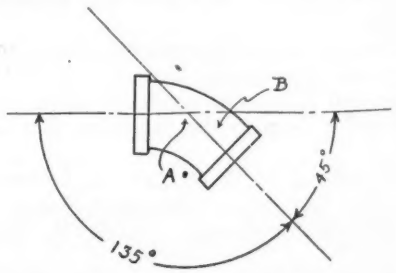


FIG. 2. DIAGRAM EXPLAINING TERM 45-DEG. ELBOW

Perhaps new rings are all that is necessary, but it seems as if he must get some knocking in the cylinder if a loose piston is the trouble. An engine turning 108 r.p.m. with no compression and looping the expansion line should, to behave properly, pound like a trip hammer.

I notice N. G. Near's comment on the 45-deg. elbow. When a line of pipe is being run in a supposedly straight line and the fitter wishes to deviate from the course by 45 deg., he certainly does not come back, but still goes ahead as shown in the sketch.

Angle A, it is true, is 135 deg.; but the angle in question is B, which is 45 deg.

I enjoy H. A. Cranford's articles very much. "It pays to advertise," but when I think of being passed a check for $150, it just about completely upsets me. Such things happen only once or so in an engineer's short life and the sensation must be nerve-racking.

Who says "There's no such thing as luck?" Some years ago I worked for a multi-millionaire. He raised my salary from time to time voluntarily and at Christmas time a little extra change was in my envelope. I had never been used that way before and it was a decided novelty. After several years of this pleasure I was induced to accept a position of similar trust for a much larger concern. Now comes what may seem to be a strange statement: I could have stayed at the old plant for the same money the new position paid, but the job was not worth the money. It sounds queer, doesn't it? When you work for a real man, do you want to cheat him? If I had stayed and accepted the several hundred dollars per year increase, I would have felt that some day the bottom would drop out of my situation and I would be left without the ability to compete fairly with men receiving the salary I had been used to. TOM THUMB.

H. M. R.'s DIAGRAMS are evidently from the high-pressure cylinder and the high back pressure is the receiver pressure that is being carried.

If this is a type of engine in which it is possible to adjust the receiver pressure, it should be lowered, as the diagrams show that the steam is being expanded below the receiver pressure even with a good load on.

The expansion line does not fall off as rapidly as might appear when we analyze the diagrams and compare the pressure in the cylinder at point of cutoff and at a point on the expansion curve at which the steam has expanded to twice the volume at cutoff, measuring from the atmospheric line and not from the back pressure line.

With the point of exhaust closure shown and the back pressure carried, there should be a good compression curve.

The diagrams are quite symmetrical and the fact that the steam and atmospheric lines are parallel indicates the piston and exhaust valves fairly tight. Also, there is no excessive drop in the expansion line to indicate leakage.

I am inclined to think that the indicator is not recording the true compression curve, due to condensation in the indicator piping. JOHN A. MURDOCK.

BY H. M. R.'s statement that his cards are taken from a 12 by 24 by 30-in. engine, I assume it is a compound. The cause of the hook in the compression curve is most probably due to bad piston rings. The cause might also be a scored cylinder or, in a four-valve engine, leaky exhaust valves. The expansion line drops below the back pressure line on both ends; but when compression occurs, the expansion line rises to a corresponding drop in the compression line. This is what makes me think the piston rings are leaking. Leaking rings would also account for the high receiver pressure.

It is too bad H. M. R. did not submit more data regarding his engine, as it is impossible to analyze a diagram correctly with so little data regarding it. This is essential: Type of engine, whether simple or compound, single or four-valve, condensing or non-condensing. Strength of spring and, if possible, point of cutoff, boiler pressure and revolutions per minute; also vacuum, if condensing. If he can measure the clearance, so much the better. R. A. WOODS.

Suggestions for Improving Cards

THE CARDS submitted by C. C. N. in the Jan. 15 issue of Power Plant Engineering show too much compression on the crank end; admission may be a trifle early, while on the head end more lead should be given.

C. C. N. did not state whether his engine is of the fixed or controlled compression type. If of the fixed type he cannot change the compression, but I surmise that his clearances may not be equal; if so, rectifying that will equalize the compression, and will will also help the lead.

The vacuum he carries is entirely inadequate for a unaflow engine to perform properly; no less than 25 in. should be carried. Unless two indicators are used, cards have little value insofar as comparing the admission and cutoff points of the two cards.

The unaflow engine, if properly designed, is the most economical steam motor on the market today, but if we equip them with auxiliary exhaust valves and use them, except in case of emergency (when the vacuum fails, and only then) we lose sight of the principle of the unaflow engine altogether.

Unaflow engines do not need much lead; I have seen them run without lead, and in some cases this may be advisable. J. H. RUHL.

Some What's, Why's and How's of the Boiler and Engine Room

1. WHAT IS MEANT by the term B.t.u.?
2. What are some of the dangerous results of foaming?
3. Describe the ways in which tube failures occur.
4. What requirements are absolutely necessary in a safety valve?
5. What is wiredrawn steam?
6. Explain the principle of how water is caused to rise in the suction of a pump?
7. What prevents the piston of a duplex pump from striking the head?
8. Why is it good practice to provide an injector larger than actually needed?
9. At what point of the stroke should an engine be stopped to key up the crankpin brasses?
10. What is the difference between a crank and eccentric?
11. In how many ways can the horsepower of an engine be increased and what are the advantages of high piston speed?
12. Does increasing the length of a bearing add to the power required to overcome friction?
13. What are some remedies for cylinder condensation?
14. Why do the short parts of the Corliss cylinder cause a saving of steam?

15. What is meant by the throw of eccentric?
16. Why are dashpots used on Corliss engines?
17. What is the general practice relative to lead adjustment on large vertical engines?
18. What advantages has the piston valve?

W. E. G.

ANSWERS

A B.T.U. OR British thermal unit is the amount of heat required to raise one pound of water one degree Fahrenheit from 60 deg to 61 deg. It is also equivalent to 778 ft.-lb.

2. One of the dangerous results of the boiler foaming is that excessive amounts of water are carried over with the steam. If any of this water gets past the steam separator and into the engine, disastrous results are likely to occur in the way of blowing out cylinder heads and blowing out elbows in the piping.

3. Tube failures usually occur from: (1) Corrosion due to electroylsis or water that is absolutely free from all foreign matter that would ordinarily take up the effect of electrolysis, or water that contains excessive amounts of oxygen; (2) bagging due to excess local heating. This occurs when there is an excessive amount of scale formed or when parts of the boiler exposed to the fire are allowed to become dry; (3) cracking due to continual stresses and pulls by contraction and expansion which causes crystallization of the metal.

4. The requirements of a safety valve are that it should be always free to open, should never be allowed to stick on its seat, and that it should be of sufficient size to discharge all the steam generated at maximum capacity of the boiler.

5. Wiredrawn steam is steam that has passed through a constricted orifice with the reduction in pressure and an accompanying increase in quality or superheat. During this process, the energy of the steam is reduced somewhat.

6. Water is caused to rise in the suction of a pump because of the difference in pressure acting on either side of the column. This difference is the difference between the suction obtained at the pump and the atmospheric pressure.

7. The piston of a duplex pump is prevented from hitting the head because steam is admitted just before the end of the stroke to act as a cushion and send the piston back on the reverse stroke.

8. The capacity of an injector depends on the steam pressure, the lift or the temperature of the feed water. It is well to provide an over-size injector to compensate for variations in these factors which are beyond the control of the operator.

9. When it is necessary to key up the crankpin brasses of an engine, the engine should be stopped on dead center with the piston at either the head or crank end. In starting again, it should be turned over slowly in order to see that the clearances are sufficient.

10. A crank and an eccentric are essentially the same. A crank, however, is used in connection with the piston of a connecting rod to turn the shaft and an eccentric is used to take power from the shaft and operate some sort of valve mechanism.

11. The horsepower of an engine can be increased by increasing either the mean effective pressure in the cylinder, which can be done by raising the total pressure, or by increasing the revolutions per minute. The chief advantage of high piston speeds in an engine is that it reduces cylinder condensation, which amounts in some extreme cases to as much as 40 and 50 per cent of the water return of the engine. This reduction will naturally effect better economy in the steam consumption of the engine.

12. Increasing the length of the bearing, within limits, of course, does not increase the power required to overcome the friction. It may even reduce this power in that it reduces the unit pressure on the bearing. The friction of oiled bearings is dependent on the pressure and the peripheral speed.

13. To reduce cylinder condensation: Increase the piston speed, use better insulation on the cylinder, use the steam jacket, use superheated steam.

14. The short ports of the Corliss cylinder effect a saving in steam because they reduce the compression volume and therefore decrease the amount of steam in the cylinder per stroke for the same amount of work done by the engine.

15. The throw of an eccentric is the distance that it will move a valve in a half revolution and is comparable to the stroke of a crank.

16. Dashpots are used on Corliss Engines to effect quick closing of the steam valves. This results in less wirtdrawing and less loss due to this effect.

17. In large vertical engines, the lead is usually made larger on the crank end than on the head end to compensate for the weight of the piston rod and connecting rod.

18. The chief advantage of the piston valve is that the steam pressure is balanced on all sides and the friction is therefore reduced.

Testing a Vacuum Gage

WILL YOU kindly inform me as to how I may check up on the readings of a vacuum gage? W. L. B.

A. A vacuum gage is usually tested with a mercury column or "U" tube which should be at least 30 in. long. In making this test, simply connect the "U" tube and the gage to be tested to the same source of vacuum. The "U" tube will then register vacuum in inches of mercury, which should be measured in inches of Hg between the two levels of the medium. The vacuum gage, of course, if it is correct, should register the same reading; if not, the indicating needle should be adjusted to read correctly or else a correct chart should be constructed.

If your vacuum is obtained in a condenser where there is saturated steam, the gage can be checked with a thermometer; simply insert your thermometer in the condenser alongside of the gage; the thermometer will indicate the temperature of the steam, the pressure of which can be found from a steam table. This pressure expressed in inches of mercury, subtracted from the barometric pressure will give you the vacuum, which should agree, of course, with that of your vacuum gage.

"THE TALENT of success is nothing more than doing what you can do well, without a thought of fame."

POWER PLANT ENGINEERING

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Insuring Service

Absolute continuity of service is the prime requisite today in power plant operation. In order that the wheels of industry may be kept moving, it is essential that the wheels in the power plant be kept in rotation. Shut-downs mean loss of time, and loss of time means money. An hour's loss of time on the part of the power plant may account for the entire difference between the day's profit and loss on the company's ledgers, yet such an interruption may have been caused by an accident to a piece of apparatus of secondary importance. Under ordinary conditions the proper functioning of such a piece of apparatus may have had no great bearing on the operation of the station as a whole, yet its breakage may close down the entire plant merely because of its relative position or location in the system.

Such shut-downs are avoidable and in any well-designed plant should never occur. Where an accident to a certain piece of apparatus is liable to affect the operation of a plant as a whole, or any great part of the plant, adequate provision should be made to bypass and cut out such apparatus. A system of bypass connections, well applied, serves as a most excellent insurance against interruption to service, and will immeasurably repay the engineer for the expense of installation. In the pages of this issue, Charles L. Hubbard discusses the advantages and applications of bypass connections to various kinds of apparatus used in power plants. It might be well for us to heed the suggestions set forth in this article and to inspect our own plants with a view of determining just where the weak points are located. Having determined any such weak points, it will be an easy matter to avail ourselves of Mr. Hubbard's suggestions and insure ourselves against avoidable interruptions to service.

Suggestions such as these, however, are not alone for the operating engineer, who may improve his plant by carrying them out, but for the designing engineer as well. The proper time to install bypass connections is during the construction of the plant—not after the plant has been in operation for some time.

Details—The Keys to Efficiency

Frequently we hear the expression "that is a mere matter of detail," with the inference that a detail is of little importance and that the correct solution of the detail will have little or no effect upon the ultimate results. To the engineer familiar with development and operation of any mechanical device, no detail capable of solution is so unimportant that it does not receive consideration, for he realizes that the greatest success can be obtained only when every detail has been correctly solved.

While this applies particularly to the parts that go to make up every piece of machinery, it applies equally well to the operation of all power plant equipment. Can you imagine what the results as a whole would be if all the details of operation from the coal pile to the switchboard were just a little off?

We have compiled tables and designed charts from theoretical and experimental data to point the way to ideal conditions. Each detail is separated as far as possible from other conditions for the purpose of studying its influence on final results. Thus water is ana-

lyzed chemically to determine what effect its impurities may have upon the life of the boiler and its efficiency in operation. Then the water is treated so as to keep scale out of the boiler or to change the character of the precipitate to a soft sludge or mud that can readily be blown out. Then comes the problem, when to blow off the boiler and in many of the best operated plants this is solved by testing the density of the boiler water. Another detail now enters: From what section of the boiler should this sample be taken?

That the density shows considerable variation in different parts of the boiler, is clearly brought out by Mr. Brown in other pages of this issue. This may seem like an unimportant detail of operation to those who blow off their boilers every so often whether they need it or not; but in plants where they use the scientific method directed by tests of the water it is of great importance.

An engineer recently remarked that he was compiling a list of standard results which he would expect the men under his supervision to obtain from the various parts of the power plants, and not until these results were obtained would he cease to investigate for faults in operating methods. Undoubtedly such a course is the scientific and practical method of bringing up the overall efficiency, and the nearer he gets to his goal the greater will be the number of details to be observed and controlled.

Obtaining efficient operation is like entering a large public building with many departments: general starting and stopping knowledge is merely a start on the road to efficiency like the front door key permitting entrance to main halls and corridors. More specific construction and design knowledge leads the engineer to the point where efficiency may be found, as master keys for different floors admit the possessor to the various department offices; but only through everlasting vigilance and a knowledge of the details of construction, operation and natural laws, like the possession of special keys and combinations to strong boxes and vaults, is one permitted to obtain the highest efficiency.

Off Duty

Off Duty again. Well, these intervals of leisure certainly do come 'round in great fashion—it seems as though the time between them evaporates like water on a hot stove. That last shift just flew by like a streak of greased lighting—didn't have time for any clock watching.

How about it? Does your work interest you so that you never think of the time, or is it such as to call for a reading of the clock every ten minutes? Does time carry you swiftly along the road of your daily work or do you bend and trudge slowly along under the weight of your hours of toil? Do you read the clock or the CO_2 meter? In other words, do you like your work, or do you work merely in anticipation of your weekly pay envelope? Examine yourself critically and take a careful inventory of your capabilities. If you do not have a decided liking for your job, if it means drudgery instead of work, if the hours hang heavily on your hands, pack up and try something else! If you do not like the engineering profession, you can never hope to make a success of it.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

For success in engineering it is essential that you possess the necessary amount of professional enthusiasm. This, of course, may be said of any other profession as well, but it is doubly important in the case of engineering. An engineer must have a natural aptitude for the profession—an aptitude similar to that which takes a duck to water. Find out whether you possess that aptitude. Quoting the words of Arthur West in a lecture at Johns Hopkins University, "Examine your capabilities dispassionately and see if you have a real love for engineering. Because a boy can fix an electric doorbell does not argue him a potential Nikola Tesla. But if you do have a passion for engineering, go to it! The engineer can no more attain success without professional enthusiasm than the boiler can drive the turbine without steam pressure.

"If your main idea is money, leave engineering and follow some purely commercial career in which money is the legitimate end and aim. If money is all you have in your mind, you will not attain first rank in engineering, even from the financial point of view. What the world needs, and what it is willing to pay a high price for, is the engineer who is so in love with his job that he makes himself better able to handle his specialty than anyone else."

The personal satisfaction in the final results of one's work rather than the material reward which it brings, is the final test which stamps a man an engineer. He is a maker, a constructor, a creator, and, in this love of creation, he ranks with the artist and in it will find the foundations for any degree of success.

The engineer takes the raw material of the universe and with the aid of the fundamental laws of nature he shapes them for the comfort and betterment of humanity. Whether it be in the construction of a great suspension bridge or in the scientific firing of a boiler, each man's work tends toward the same ultimate end. Look about you! Wherever the eye rests, it will behold the results of the engineer's mental and physical effort. It is a wonderful profession.

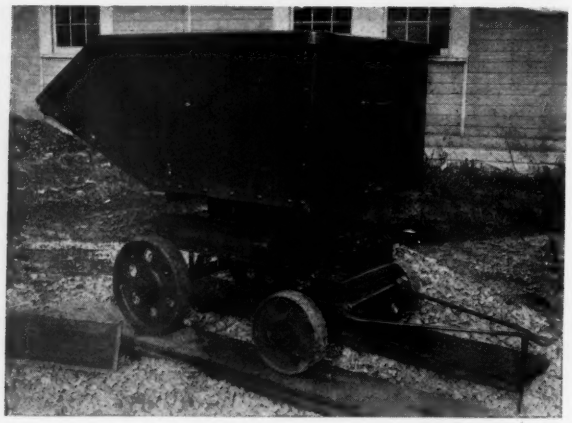
So, if, after analyzing yourself, you find that you possess the necessary qualifications of an engineer, go to it with redoubled effort and joy. Engineering is a difficult and laborious profession, but to its devotees, a delightful one. Interest increases as your work goes on—it follows the natural law of compound interest, and finally, when you are ready to enter upon your last and ultimate Off Duty, you will leave behind you riches which would incite the everlasting envy of emperors and kings.

Scoop Car Trailer

A NEW TYPE of hand-pulled scoop car trailer has recently been developed by the Easton Car and Construction Co., which differs from other scoop cars now on the market in that it is equipped with flat tread instead of narrow gage track wheels. This scoop car trailer, therefore, is not confined to the limits of a narrow gage track system but can be pulled around anywhere, inside or outside. It is easily handled by one man.

In addition to the handling of sand, ashes, concrete, mortar, gravel, coal and other loose material usually handled by narrow gage track cars, this new car extends its usefulness to practically all industries, in a variety of work such as the handling of steel chips, small forgings and castings, bolts, etc., in machine shops and foundries.

The car has a capacity of 27 cu. ft., is mounted on a structural steel turntable, permitting it to be turned around in any direction and dumped from any one of the four sides.



HAND-PULLED, FLAT TREAD, CAR TRAILER

The wheels are of the roller-in-the-hub type, and the front axle of the swivel type, equipped with machined cast-iron ball-bearing turntable, permitting the car to be turned in practically its own length. Its especially low loading height is of particular advantage in hand loading.

New Line of Switchboard Instruments

ACCURACY as well as rugged construction are the features of a new line of switchboard ammeters and voltmeters just placed upon the market. Movements of these meters are light, thus assuring a minimum of pivot and jewel wear, obviating injurious effects from shock or vibration. The scales have been prepared to give a pleasing appearance, as well as maximum legibility. All instruments have external zero adjusters.

These instruments which operate on the D'Arsonval principle and embody all the latest improvements in instrument design, are finished in a dull black marine. Overall dimensions are 7 7/16 in., and the depth is 2 13/32 in. The weight of each instrument is 9 lb. The movement complete, with core and pole pieces assembled can be removed as a unit, thus facilitating inspection and repairing. Only a slight adjustment is necessary to make replaced elements operate with the same accuracy as the original elements.

NEW TYPE OF VOLTMETER

Special instruments may be had with this type instrument for use as differential voltmeters for paralleling generators, ground detector voltmeters or "leakage detectors," double reading ammeters and voltmeters, pyrometer millivoltmeters, temperature indicators and speed or frequency indicators.

American Engineering Council Meets

ENGINEERS and technologists from all sections of the country held a two-day meeting at Syracuse, N. Y., Feb. 14 and 15, which was opened with the announcement by Herbert Hoover, president of the American Engineering Council of the Federated American Engineering Societies, of the appointment of a committee on Elimination of Waste in Industry.

The appointment of this committee, according to Mr. Hoover, marks the beginning of what is officially styled by this council as a great national assay of waste, in which from 100,000 to 200,000 engineers functioning through the council will attempt by studying the nation as a single industrial organism to locate the weaknesses in the country's production system.

A preliminary survey, it is announced, has already been organized and the different elements making for production waste, such as labor conflict, decrease in individual productivity, lack of co-ordination, and many other sources of industrial failure will be brought under the close scrutiny of the organized engineers of the nation with the aim of solving pressing economic problems.

The personnel of this committee, as announced by Mr. Hoover today, follows: J. Parke Channing, Dr. Ira N. Hollis, L. W. Wallace, H. R. V. Scheel, L. P. Alford, George D. Babcock, F. G. Coburn, Morris L. Cooke, Harington Emerson, E. E. Hunt, C. E. Knoeppel, Robert Linton, Fred J. Miller, J. H. Williams and Robert B. Wolf.

In addition to his appointment on this committee, L. W. Wallace was elected secretary of American Engineering Council, succeeding L. P. Alford of New York.

Mr. Hoover, who is president of the American Engineering Council, is also a member of the committee of which he is one of the principal sponsors. He will

take a leading part in the assay of waste which the committee will conduct for the council.

The committee, it was announced, has already started work and a nation-wide plan, described as the most ambitious movement in the direction of solving economic problems ever undertaken by American engineers, will be put in operation from the New York and Washington headquarters of the council at once.

Unemployment, intermittent employment, strikes, lock-outs and restrictions of output are waste. Disuse and misuse of machinery and equipments and losses of manufacturing materials are likewise waste. Stabilization of industry is a crying need, and also an engineering problem. Labor, capital, management and the consuming public stand to gain if common constructive action can be taken to lessen the idleness of men, idleness of productive equipment and the utilization of material. These problems, it was announced, will be dealt with and it is proposed for this purpose to organize the engineers of the country on a territorial basis, each state having an engineering organization, with the American Engineering Council the executive organ of all.

State Association of Municipalities to Develop Power

A STATE association of municipalities was organized for the purpose of developing hydroelectric power sites in California. Charles A. Bliss, of Sacramento, is acting as temporary chairman. An organization commission composed of Mayor Horace Porter, of Riverside; C. A. Mason, of San Francisco, and D. W. Carmichael and Robert L. Shinn, of Sacramento, will submit a plan of work.

According to C. A. Mason, there are many undeveloped sites in the mountains which will yield about 7,000,000 hp. in energy. He said that the municipality or public agency is best suited to do the work and cited Los Angeles, which produces power 35 per cent cheaper than private companies.

Mayor Paul M. Narboe urged haste in starting the work. He stated that there are 21,000,000 acres of undeveloped land in the state and seven times as much water as is needed to irrigate them is going to waste. The sites in the mountains should be properly surveyed, he added, and much money would be needed for the work.

News Notes

MAY 23 through 26 has been set as the date of the spring meeting of the American Society of Mechanical Engineers. It will be held in Chicago at the Congress Hotel. Sessions are planned by the professional sections of aeronautics, fuels, management, material handling, machine shop, power, forest products and railroads.

HERETOFORE the Fisher Governor Co. and the Fisher Supply Co. have always been under the same management, being operated as two departments of a single organization. On Jan. 1, 1921, however, a reorganization took place whereby these industries became two separate and distinct corporations. While in many instances the stockholders will continue to have holdings in both corporations, each organization now has individual officers and a district management. Rapid growth in both departments is responsible for the departure. The volume of business transacted during the past few years made a more complete and increasingly active management imperative. Under the new system, the former policy will be adhered to and increased efficiency, prompt and careful service and larger stocks will still be the aim of both industries. The Fisher Governor Co. will continue under the direction of M. A. Fisher as president and J. H. Fisher as secretary, while the officers of the Fisher Supply Co. are L. C. Abbott, president, and J. A. McDonnell, secretary.

THE LOCOMOTIVE SUPERHEATER CO. has acquired the patents and business of the Locomotive Feed Water Heater Co. and will conduct the further application of the apparatus for preheating feed water through its regular engineering, inspection and service organizations, to which has been added the operating organization of the Locomotive Feed Water Heater Co. This consolidation of resources and effort promises more intensified development and better service to the railroads.

THE C. H. WHEELER Manufacturing Co. has recently opened a branch office in the Leader News Building, Cleveland, Ohio, with W. K. Eicher in charge.

GEORGE J. BLANTON, who for the past four years has been connected with the Engineering Sales Department of Chain Belt Co., Milwaukee, has been made New York District Manager.

THE VULCAN Soot Cleaner Co., of Du Bois, Pa., announces the appointment of George Lockwood Simonds as vice president in charge of western sales with headquarters at 828 Transportation Building, Chicago, succeeding Ernest E. Lee Co. Mr. Simonds will give personal attention to business in northern Illinois.

ANNOUNCEMENT is made by The Hooven, Owens, Rentschler Co., Hamilton, Ohio, of new offices at Richmond, Va., Omaha, Neb., and Boston. John Fensom Co. will be representative in the Virginia territory, The Sunderland Machinery and Supply Co. in the Omaha district and Walter T. Paine at Boston.

THE SALES ORGANIZATION of Elliott Company, Jeannette, Pa., met together in a three day's convention Feb. 10, 11 and 12. All of the district managers, sales engineers and sales agents of the company were present and a very profitable time was spent. An exhaustive study was made of the company's products, especially the line of Elliott-Ehrhart condensers. The convention was addressed by the company's engineers and experts in the various phases of design, manufacturing and selling the Elliott products, as well as those of the Lagonda Manufacturing Company and Liberty Manufacturing Company. The convention was entertained at dinner on the evening of the 11th, as the guests of Mr. Elliott.

JOHN HUNTER recently accepted the position of chief engineer of the Heine Safety Boiler Co. Mr. Hunter was born in Scotland where he was educated and served his engineering apprenticeship. He entered the marine service as junior engineer on the Red Star Line S. S. "Westernland," being promoted later to first assistant engineer on the S. S. "Friesland" of the same line.

In 1895 he was transferred as senior first assistant engineer to S. S. "St. Louis" of the American Line, then being built at Cramp's Shipyard in Philadelphia. He

served in this capacity until the outbreak of the Spanish American War in 1898, when he was appointed chief engineer of S. S. "St. Paul," operated by the U. S. Navy, with Captain Sigsbee in command. When the "St. Paul" was returned to commercial service between New York and Southampton he continued as chief engineer.

In August, of 1905, Mr. Hunter accepted the position of chief engineer of power plants of the Union Electric Light & Power Co. of St. Louis, where he had charge of the design, construction and operation of the electric generating stations of the company, which supplied practically all the lighting, industrial power, as well as a considerable share of the street railway power used throughout the city. The largest station of this system, the Ashley Street Station, was the scene of much pioneer development work. For instance when Mr. Hunter assumed charge of the plant it was rated at 12,000 kw., and in the same building by adoption of radical improvements he increased the power to 116,000 kw.

In 1913 he was associated with Hugh L. Cooper of the Keokuk Water Power Co., in the building of the hydroelectric plant, which when completed furnished the Union Electric Co. in St. Louis with 45,000 kw. transmitted at 100,000 v.

In 1917 Mr. Hunter was called east by the U. S. Government to assist in the shipbuilding program. He was first detailed as government representative in charge of the Submarine Boat Co., and later transferred to the Standard Shipbuilding Corporation, Shooters Island, N. Y. Mr. Hunter has been active in committee work of the leading engineering societies of the country and a host of friends in the central station and power plant field will welcome his entry into a position where he can bring his experience to bear on the design and operation of central stations throughout the country.

HUGH R. CORSE who, for the past 6 yr., has been general sales manager of the Titanium Bronze Co., has been elected to the staff of the Lumen Bearing Co., located at Buffalo, N. Y., in the capacity of sales engineer. This addition to the staff is one made necessary by the growth of this company which has recently undergone considerable expansion to meet its earnings. Mr. Corse enjoys a large acquaintance with the executives and engineers of the automotive industries, as well as with the machine-tool industry and is not unacquainted with the Lumen Bearing Co.'s products for, prior to his connection with the Titanium Bronze Co. he was in charge of its district sales office in Detroit for 5 yr.

THE STRONG MACHINERY & SUPPLY CO. will, on March 1, move its New York City office from 21 Walker Street to 292 Church Street.

ANNOUNCEMENT is made by the Atlas Valve Co., Newark, N. J., that in rounding out its line of valves it has now added the Ideal automatic pump governor, having acquired sole patents and rights to manufacture by purchasing from the Ideal Automatic Manufacturing Co.

STERLING H. BUNNELL, Ralph G. Macy and J. C. Henriques recently organized a corporation under the name The Engineering & Appraisal Co., with offices at 103 Park Avenue, New York City. The company will specialize in steam and electric, power and heat plants, factory equipment, organization, operation, ice production, design and construction.

U. S. CIVIL SERVICE COMMISSION announces an examination for senior mechanical engineer, Grade 1, receipt of applications to close March 29, to fill a vacancy in the Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C., at $3000 to $3600 a year, and vacancies in positions requiring similar qualifications at salaries ranging from $3000 to $5000, or higher or lower compensation. Competitors will be rated on general and technical education and preliminary experience, responsible experience and fitness, and must not have reached their seventieth birthday on the date of the examination. In view of the retirement act, should the appointing officer so request, certification will not be made of eligibles who have reached their fifty-fifth birthday. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Trade News

ELLIOTT COMPANY announces that James E. Watson, formerly sales manager, has taken up the duties of general manager. C. L. Brown, for many years district manager of the Chicago office, is now general sales manager, and W. W. Turner, who has been connected with the Chicago district office, succeeds Mr. Brown as Chicago district manager.

THE DENVER OFFICE of the Jeffrey Manufacturing Co. has recently been moved from the First National Bank Building to 421 United States National Bank Building.

COPPUS Engineering & Equipment Co.'s latest catalog on the subject of the Coppus Turbo Blower for undergrate draft and other industrial purposes has just been received.

BULLETINS 151, 152 and 153, descriptive of the Adsco Rotometer, Adsco Water Heaters and Adsco Angle Fittings respectively, have just been issued by the American District Steam Co., North Tonawanda, N. Y.

HEATING AND COOLING Equipment Catalog No. 3 of Alberger Heater Co., Buffalo, N. Y., describes heaters for oils, gases, chemicals, feed water, heating systems and domestic service, and coolers for gases, oil, air, brine, water and chemicals; also, economizers and interchangers.

LADEW LEATHER BELTING is an 80-page catalog describing the manufacture of Hoyt leather belting from the rough hide to the finished product. Belting rules and tables are given, with a data sheet for analysis of belt drives for highest economy. Belting accessories are also included. Edward R. Ladew Co., New York City, is the manufacturer.

THE GENERAL ELECTRIC CO., in Bulletin No. 42,300A, superseding Bulletin No. 42,300, describes and illustrates its line of steam engine-driven generating sets which are especially manufactured for marine installation. The bulletin includes a cross section drawing showing the assembly of 6½ by 5-in. cylinder forced lubrication sets. Each part in the construction of these generating sets is described separately and fully illustrated. Reference is also made to alternating-current generating sets and their uses.